Devoted to Civil Engineering and Contracting

March 19, 1925

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Engineering News-Record

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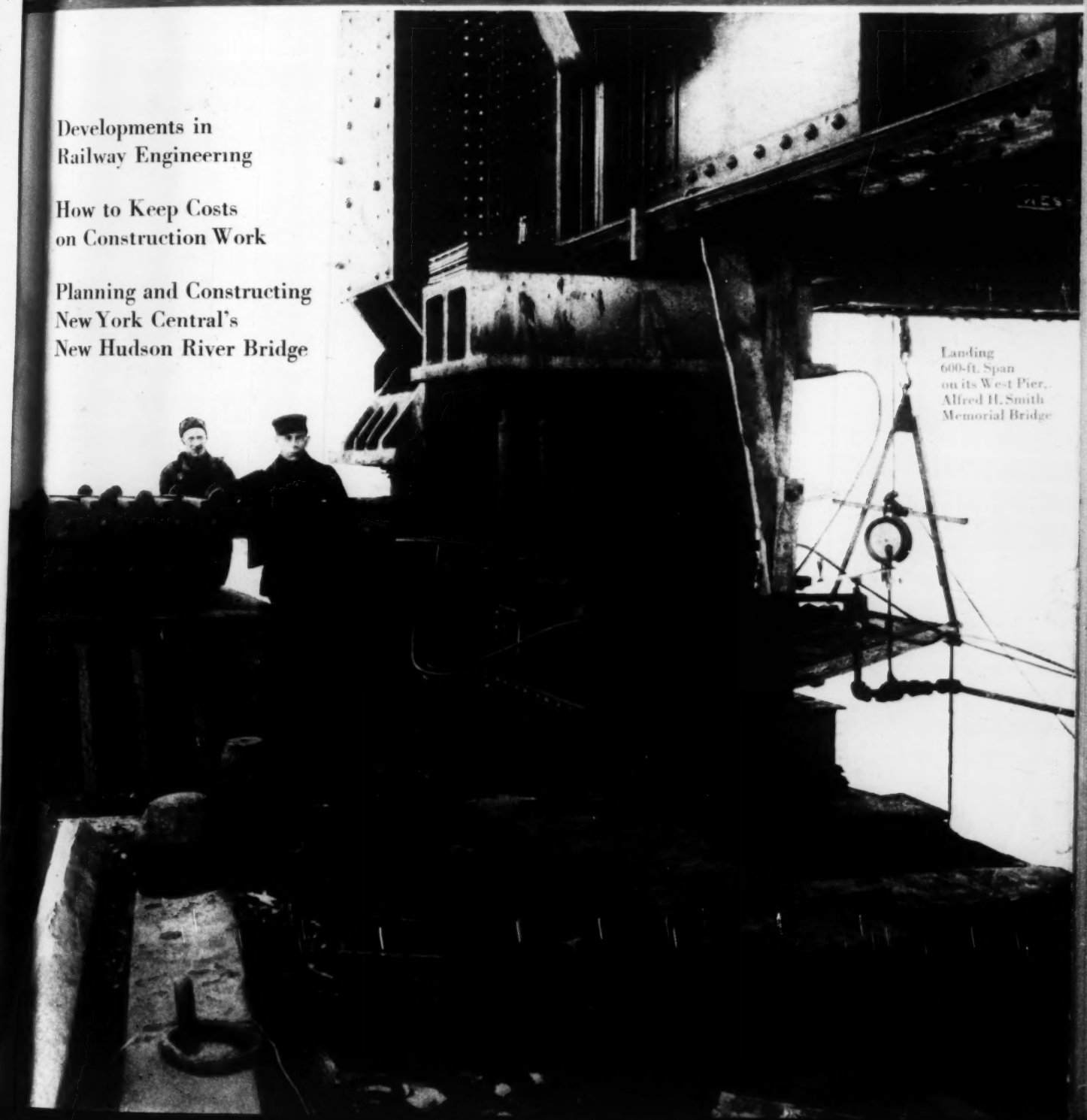
Developments in Railway Engineering

How to Keep Costs on Construction Work

Planning and Constructing New York Central's New Hudson River Bridge



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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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Mapping the United States

AFTER a number of unsuccessful attempts Congress at last passed—and the President signed—the Temple Bill providing for the completion of the base topographic map of the United States. This is excellent legislation. Engineers do not need instruction in the utility of the familiar topographic quadrangle maps; they are among the fundamental necessities of engineering operations. But there have been too many gaps even in populated territory to give the system complete usefulness. By the new law we are assured of a complete coverage of the country in a reasonable time. Not only will the map service be thereby increased but the geodetic control necessary for the extension of the map system will be most useful as a control for engineering projects under way or in prospect. More cities will be able to avail themselves of the geodetic control method of basing their local survey system.

An Engineer's Achievement

ANOTHER loss to engineering is recorded this week with the passing of John F. Hayford. His outstanding contribution to the advancement of mankind was his study of isostasy, that remarkable hypothesis of a constant tendency toward gravitational balance of all parts of the earth's crust. Hayford measured and calculated from a great mass of geodetic data the initial proof of the hypothesis, and thus transferred it from the realm of speculation to a firm foundation, where, with but minor readjustment, it promises to maintain itself. Not often is opportunity granted to the engineer to take direct part in unlocking the larger mysteries of nature. Hayford was fortunate enough to find such an opportunity in his work and he was prepared to meet it. Already the truths he developed have had a guiding influence on the work of geologists in their attempts to decipher the ancient record of the earth's long-past changes, and there is little doubt that the future understanding of the growth and development of our little planet will be related very closely to the facts which Hayford brought to light.

Fordwarding Arbitration

SOME difficulty has arisen in the final agreement by the Joint Conference on Uniform Construction Contracts because some of the members insist that the clauses in that contract on arbitration be made to conform to the New York and New Jersey arbitration law. The exact nature of the controversy has not been made public, but it is evidently in the matter of details, which will be worked out sooner or later. Meanwhile the principle of compulsory arbitration of contracts goes on apace. A federal law was signed this month by Mr. Coolidge and the State of Oregon has just enacted a statute similar to the one now in force in New York. The movement is one which all engineers should forward. For the benefit of those who have not followed this legislation is may be stated that this new form of arbitration merely makes it a matter of law that when two parties to a contract agree to an arbitration clause such arbitration when invoked by one of the parties becomes compulsory and the verdict of the arbitrator has all the force of a judge's decision. Thus may be saved much legal procedure and costly delay, to say nothing of the probable salutary effect in restraining a possible violator of the contract who indulges in such violation in the expectation that the other party will endure much rather than to enter court action. Whether or not the jointly adopted standard construction contract has the exact procedure of the excellent New York law, its arbitration clauses are on the right track and the principle they express mark progress in the conduct of construction business.

Bonus and Penalty Legal

ANOTHER decision of the Kentucky courts on bonus clauses in construction contracts appears to reverse the decision in the famous Paducah school building case commented on editorially in our issue of Oct. 16, 1924. The reversal is only apparent, however, for it appears, from the latest decision, that the two cases are quite different. In the Paducah school building contract the bonus and penalty clause was negotiated with the contractor after the bidding was closed. In the case recently decided, the Louisville Sewer Commission case, the premium and liquidated damages clause was a part of the proposal form so that all bidders estimated with preknowledge. In this difference lies the illegality of the Paducah school contract and the legality of the sewer commission contract in respect to bonus and penalty. Specifically in the decision handed down by the Court of Appeals on Feb. 10 in the sewer commission case it is held (1) that the sewer commission had met every requirement of the statute and that it was entirely within its power in adding the premium and liquidated damage clause providing it was written on the proposal form, thereby placing all bidders on an equal footing; (2) that the contractor is liable to deduction for delay after, and is entitled to extra pay for completion before, the date set, as written in the contract. This decision reverses a previous Circuit Court decision in the same case which held the penalty clause valid but declared the premium clause invalid.

Road Accident Rate Less

FATALITIES from motor vehicle accidents are increasing in number and decreasing in rate. This is the tale of virtually all states whose motor vehicle registration or highway departments have kept counts long enough to have comparative data for a period of years. In Massachusetts last year there were 672 fatal accidents due to motor vehicles. Each accident was in-

vestigated and its cause determined by inspectors of the State Registry of Motor Vehicles. In their records we find again the old story of greatest danger on a straight, smooth, dry road in daylight in clear weather. Curves, intersections, railway crossings, ice, snow and obstructed vision were comparatively safe conditions according to the accident counts. It is not those familiar conclusions, however, that interest one most in the Massachusetts statistics. The fact of interest is the proof they give of a declining accident rate. In ten years the average annual increase in vehicles registered has been 23.2 per cent. The corresponding increase in persons killed has been 12.9 per cent and in persons injured 23.3 per cent. In 1924 there were registered 683,093 motor vehicles and the ratio of motor vehicle deaths was 0.00103 and of motor vehicle injuries was 0.02866. Except for 1923, which seems to have been the banner year of highway safety in Massachusetts, this ratio is less than half that of five years ago. This shows progress in the appreciation of safety needs, but it must not be forgotten that so long as motor car use increases, total accidents will increase unless the accident rate materially decreases, and after all it is the total accident toll that is important. Unceasing effort must be devoted to the promotion of highway safety.

For a Loose Leaf Manual

PROBABLY no book dealing with railway engineering matters is so widely known and used as the manual of the American Railway Engineering Association. In its present form it is a large volume of about 1,000 pages which is revised annually by the publication of a supplement following each annual meeting of the association. In this form the book is hard to use and carry about. One must look through each revision before being sure that the material contained in the original volume is still up-to-date, and if any part is wanted at a point away from the office the whole volume must be taken along. At the association's convention in Chicago one of the committees suggested that the association make a change in the form of the manual, that it be put out in a standard loose leaf form with an adjustable binder for the main volume. With such an arrangement each year's revisions could be inserted in their proper place as soon as published instead of being kept in separate supplements until a new edition of the manual appears, thus keeping the whole book up-to-date. When only one section is in use, as in the case of the committees, such sections can be lifted out and placed in small binders for convenient handling. The present time seems to be an appropriate one for putting such an innovation into effect. The edition of 1921 is badly out of date and the supplements, taken together, make a volume nearly as large as the manual. Moreover, the association has ample funds to undertake the work. Such a change would make this remarkable volume of infinitely more value. And the idea might be extended to some of our other societies which are engaged in standards making, such as the American Concrete Institute and the American Society for Testing Materials. Nothing so adds to the cluttering up of a professional man's library as the large "proceedings" or "transactions" which frequently contain duplicate matter, and nothing is a larger burden to the society budget than the regular annual printers bills.

Dangerous Impact Action

SURPRISINGLY little attention has been given to the test results of impact on highway bridges carried out within the past few years, chiefly by Prof. A. H. Fuller and a committee of the American Society of Civil Engineers. The work has not received as full publicity as it merits, but the figures are large enough to call for serious consideration. For example, the table of observed impact values given in our issue of Oct. 16, 1924, p. 261 (recently summarized briefly in a committee report to the American Society of Civil Engineers), contains quite a number of figures exceeding 100 per cent, and not a few exceeding 150 per cent. Such figures plainly mean that the action represented is somewhat more than secondary in importance. They suggest that impact may become a central point in design, taking precedence over such incidentals as wheel spacing or precise distribution of load.

Even with smooth concrete floor the impact is measurable, which indicates that to some extent impact originates in the vehicle. Roughness of floor is controling, however. That a strong pounding action is produced by a rough floor has long been recognized instinctively. But while the effect was clearly demonstrated by the rapid local destruction which developed at the edges of incipient roughnesses, data were lacking for taking account of it in proportioning the parts of the bridge. With the figures now at hand a start is made toward supplying the necessary design data.

The work already done makes it very obvious, however, that a great deal of further stress-measurement work is necessary before our knowledge can be considered reasonably satisfactory. Erratic variations reflect the variable nature of the actions involved in impact effects; and where such variable actions are concerned, it takes many check experiments to give assurance that limiting values have been obtained. Impact is measured more properly by the extreme or highest values obtained in a series of experiments than by average values, since the object in designing a structure for impact is to give it sufficient strength to withstand the stress that may be imposed under some infrequent condition. Professor Fuller's work so far indicates that extreme values range around 150 per cent of average values of impact; but if impact is so erratic as to produce this large ratio in one series of tests, even larger maxima may be found in more extended testing.

Because of the variability of the effect, there is the further possibility that under full loading (with a number of trucks on a bridge at the same time) larger impact percentages may result than in the case of only one or two trucks. The effects due to the individual trucks may neutralize each other or they may reinforce each other, and in the extreme case they may produce a larger total stress than corresponds to the sum of their individual effects. Even if this should prove not to be the case, however, it does not seem likely on the basis of the present results that full-load impact would be any lower than the percentages obtained in the present tests.

These questions, which bear directly on the safety and permanence of the thousands of bridges on our main highways, point to the desirability of extending and duplicating the test work already done, and repeat-

ing it for bridges of a variety of types. On the basis of the present data it can hardly be doubted that impact is the largest item of uncertainty in bridge design and that it makes necessary unduly large margins of safety.

Hard-Working Engineers

TRUE to its reputation of being a hard-working organization the American Railway Engineering Association brought its 26th year to a close by a convention made up of six long and crowded sessions at which some twelve hundred pages of committee reports were received and acted upon. As is always the case at these annual conventions of the railway engineers part of the data presented was as information only and part was data corrected upon the basis of discussion during its presentation during a previous convention. Such material is not likely to draw out more discussion and as a result there was little discussion of a number of reports and a seeming lack of interest in some of the meetings. Actually, however, there was no lack of interest as was evidenced by the crowded convention hall and the active discussion of controversial subjects.

Regardless of these facts some changes in the method of procedure are necessary in order to give more detailed consideration to the reports if the convention is not to become a rubber stamp for its committees. At the present time the material to be considered is so bulky that the average busy engineer has not sufficient time to give it careful study before coming to the convention and as a consequence comes unprepared. The amount of this material can be reduced considerably by a more careful selection of the subjects assigned to the committees. This is a matter for the directors to deal with. As we said last year, too much time is given to writing specifications that might better be written by other societies. There has been some improvement in this respect since last year, but much more can be done. There has been a notable improvement in the way of co-operation between the committees and between the committees and outside organizations. The association is to be congratulated upon this change. Another fruitful field for the reduction of material to be considered is in elimination of a lot of surplus material that now gets into the committee reports. If a few of the large reports were referred back to committee for reduction in size the desired effects might be obtained.

All this has been said in no spirit of criticism but rather in a spirit of introspection because we feel that the American Railway Engineering Association with its past and present record of accomplishment should not become so involved in the preparation of relatively unimportant data as to be deprived of its best features—the full discussion of subject matter presented for inclusion in its manual. This comment on last week's convention would not be complete if it left the impression that the meetings were fruitless and the report unimportant, for such is not the case. The discussion was active and worth-while and some exceptionally fine reports were presented. Such reports as that of the Committee on Stresses in Track, the historical sketch of automatic train control by the Committee on Signals and Interlocking, the classification of construction timber by the Committee on Wooden Bridges and Trestles, and the specifications for open hearth rails by the Committee on Rails, are but samples of the valuable data prepared by the association's hard-working committees.

Selecting New Americans

IMMIGRATION problems and difficulties were submerged but not settled by the national quota act of a year ago. That act was a decided improvement over the one which it supplanted in that it provided more humane means of rejection and avoided much of the congestion at certain ports at critical periods, but it still has the great error of being non-selective except as to nationality. It is readily admitted by everyone that nationality is about the last criterion of admissibility which would be chosen if the aim of restricted immigration—that is to get the best possible future Americans—is the end in view. Nationality, however, has to be chosen apparently because of the difficulty of settling upon any criterion that will not be offensive either to some foreign nation or domestic group.

The fact has always been apparent, since the necessity for restricted immigration has been obvious, that what is needed is selection of immigrants according to the needs of the country, which means selection according to trades and occupation. If we are short of farmers, we should seek farmers from abroad; if bricklayers are in demand here why not look for bricklayers in Italy; when the steel mills of Pennsylvania need a thousand puddlers, who would make better immigrant material than the world famed puddlers of Wales? But in the way of such sensible procedure have stood the labor unions and their fixed opposition to contract labor. No selection of immigrants will be possible without some sort of prearrangement by the employing interest here and such prearrangement is not only illegal but it has hitherto been regarded as so inimical to labor that no statesman could be induced to touch it as a policy.

Things look a little brighter now. Labor, it is said in Washington, is beginning to see that restriction of its own recruiting from Europe is not to its advantage. It is seeing that the selective quota is being taken up too much by the middleman class, who take from production too frequently rather than add to it and who, if grown too great, will be just as dangerous to labor progress as to capital progress. And so, the report is, labor is willing to talk terms on the contract labor law. Provided foreign recruiting of labor is precluded when the object is to bring in strikebreakers, the American Federation of Labor will probably favor selection of immigrants by trade or by contract. It is willing that the prospective employer be allowed to seek out a steady high grade skilled man, reach an understanding with him and pay his way over. Such a man would of course have to come within his national quota—unless we can devise some way of overcoming this method of attempting to classify human beings—but by arrangement with the government the bulk of quotas could be filled with needed and desirable persons rather than as it now is with those who happen to be financially and physically acceptable but for whom there is no insistent demand.

Education of the people to this new form of immigration selection is necessary before Congress will feel the urge to consider it. Builders and engineers should be eagerly in favor of it, for it will produce the kind of new Americans that will upbuild the construction industry rather than add to the already crowded ranks of barbers and waiters and to that group which has already changed the face of the City of New York—the garment worker.

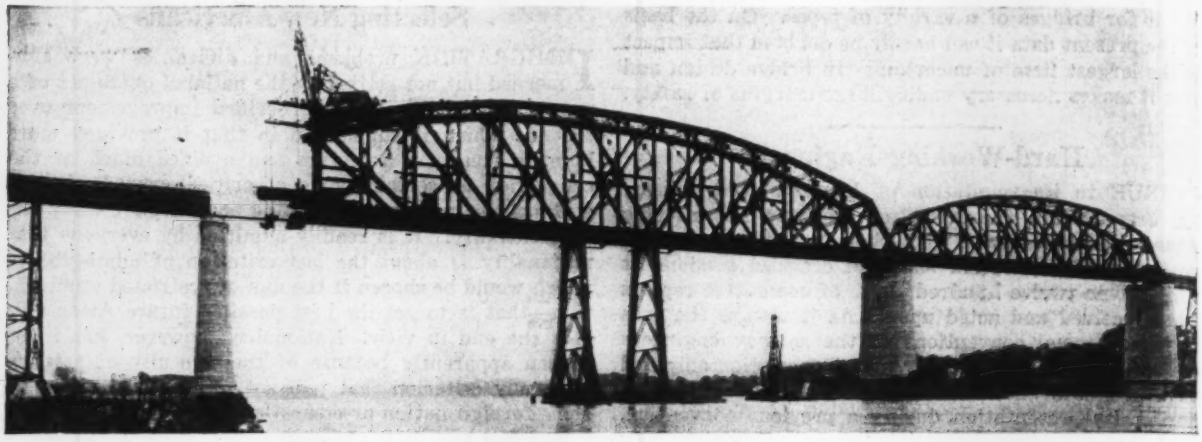


FIG. 1—CASTLETON BRIDGE BEFORE COMPLETION OF CHANNEL SPAN

Planning and Construction of New York Central Lines' New Hudson River Bridge

High-Level Crossing Project Long Delayed by Controversy Over Span Lengths—Channel Span of All-Riveted Type—Concrete Slab Deck on Approach Viaducts—Eliminating Secondary Stresses

By H. T. Welty
Engineer of Structures, New York Central R.R. Co., New York

On Oct. 23, 1924, the jacking into final position of the 600-ft. span of the high-level bridge which has been built by the New York Central Railroad Co. over the Hudson River south of Castleton, N. Y., and known as the Alfred H. Smith Memorial Bridge, marked the virtual completion of the last link in the Hudson River Connecting R.R. joining the West Shore R.R. on the west side of the river with the Boston & Albany R.R. on the east side. This $25,000,000 project had its inception about fifteen years ago, and its completion was largely due to the vision and energy of the late president of the New York Central Lines, Alfred H. Smith, in whose memory the bridge has been named. The bridge is noteworthy not only in the length and weight of the fully riveted truss spans, and the height and length of the viaducts, but also in a number of features of its design and construction. Among them are the ample provision made to facilitate inspection, the waterproofed concrete deck on the viaducts, the design of the chord splices, the methods used in the fabrication to reduce secondary stresses, and the design and construction of the main piers. The present article describes the development of the structure.

For many years the New York Central has maintained two bridges over the Hudson River at Albany, one for freight and the other for passenger traffic. These bridges are double-track structures and both have swing spans, the tracks being at low level. From Albany both west on the New York Central and east on the Boston & Albany the grades are heavy, necessitating the breaking up of freight trains into several sections and the use of pusher engines up the "Albany Hill," thus entailing excessive operating expense, especially for freight movements. The yard facilities in the vicinity of Albany are inadequate and could not well be increased. Openings of the swing spans had become so frequent as to seriously interfere with train movements during the navigation period. It was these obstacles and limitations that led to the development of plans for a new high-level route to carry through freight between Western points and New York and points on the Boston & Albany and its connections.

Deciding on Span Arrangement—Preliminary work on surveys, started in 1913, finally narrowed down to two locations, and sufficient borings were made to locate the rock at the river crossing. The line finally adopted combines the advantages of favorable gradient with reasonably close proximity of rock at the proposed pier locations.

Soon after the surveys had been started, the Hudson River Connecting Railroad Co. was incorporated, permission to proceed with the construction was obtained from the Public Service Commission of the state, and a bill was passed by Congress authorizing the construction of a bridge.

The first tentative bridge plan prepared contemplated the construction of three 390-ft. simple truss spans. In order to span the 400-ft. government channel this plan was revised to show two 480-ft. spans before it was submitted to the War Department in August, 1916. Public hearings on the proposed construction developed considerable opposition to the location of piers between the government dikes, built to confine the river and prevent silting of the channel, and located about 1,000 ft. apart. The opposition was based on the claim that such piers would be an obstruction to navigation, especially should oceangoing vessels ever be operated to Albany, and that piers would be conducive to the formation of ice jams. This opposition became so insistent that a compromise plan showing a 600-ft. span over the dredged channel and a 408-ft. flanking span to the east was prepared. It was approved by the Secretary of War in 1917.

However, this plan was not satisfactory to the interests opposing the construction, and the agitation was carried to the state legislature, which in May, 1917, passed a bill revoking the company's charter and granting a new charter requiring a 1,000-ft. clear span over the river. Later in the year a temporary injunction was obtained restraining the company from proceeding

with work on the bridge. The case was carried through the various state courts and finally to the supreme court of the United States. Each in turn rendered a decision in favor of the company, these decisions being based on the recorded approval of the proposed construction by the Secretary of War, who has jurisdiction over the crossing of navigable streams. The delay caused by this controversy necessitated an application to Congress for an extension of time of completion, and it was not until February, 1921, that all legal matters had been settled.

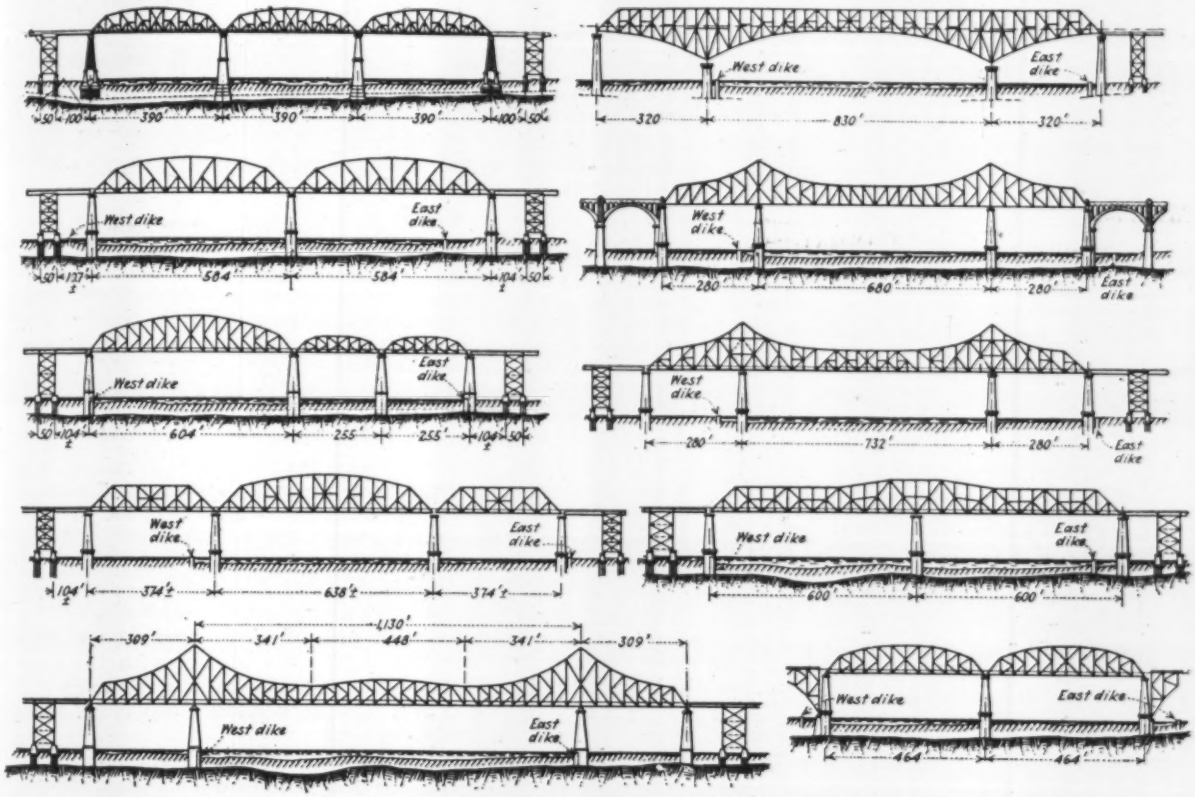


FIG. 2—SOME PRELIMINARY DESIGNS PREPARED TO MEET VARIOUS WATERWAY DEMANDS

During this period very little definite development work on the design of the bridge could be done other than the taking of additional borings to establish the rock contour more accurately. However, the early estimates had been supplemented by estimates of cantilever bridges having channel spans ranging from 600 ft. to 1,000 ft., of a continuous bridge of two spans, and of an arch span similar to the Hell Gate arch. The plan finally adopted and approved by the Secretary of War, consisting of two simple spans, of 600 ft. and 408 ft. c. to c. of piers, respectively, was the most economical of the designs which would meet the government requirements. The arch design was impractical because of unsuitable foundation and erection conditions, besides being prohibitive in cost. The cantilever design giving a 1,000-ft. clear channel was also prohibitive in cost. It was estimated that such a bridge would have increased the cost approximately $2,500,000. Some of the designs studied are illustrated in Fig. 2.

While various designs for the main crossing were considered, all of the early estimates were based on steel viaduct approaches. These estimates contemplated 50-ft. tower spans and 100-ft. intermediate spans, with open timber deck. During the years immediately following the close of the war, the price of steel mounted so rapidly that consideration was given to the possibility of economically substituting 150-ft. concrete arches, which, as estimates indicated, would cost no more than steel viaducts. The arch construction would have had the advantage of low maintenance cost. Prices were fluctuating so rapidly, however, that an actual comparison of bids was considered the only reliable method of comparison and design drawings were prepared for the viaducts for both steel and concrete arch construction. This procedure was finally not carried out, for by the time conditions were favorable for starting work the price of steel had receded materially, while the cost of concrete had advanced, and comparative costs were entirely unfavorable to concrete.

Although all legal obstacles were out of the way early in 1921, financial conditions held development in abeyance until 1922, when contracts were awarded. At this time the costs of fabricated steel and construction work generally were at comparatively low figures.

Foundations

Viaduct Piers—There were three subsurface conditions to be met in the design of the viaduct piers—hard material in the hillsides at each end of the bridge, comparatively shallow depth to rock in Schodack and Jolly Creeks, and rock at greater depth with soft overlying ground in the flats east and west of the river. The soft material was largely sand, with river mud at the top and some clay and occasional boulders beneath. On the hillsides spread footings without piles

were used, for a pressure of 2.5 tons per sq.ft. In Schodack and Jolly Creeks the piers were carried to rock in ordinary open steel cofferdams. For the foundations through the flats, after various schemes were considered, timber pile foundations were finally decided upon as the most suitable and economical. Each of these piers is 25 ft. square at the base and is supported on 81 piles driven to rock; the piles are loaded to 18 tons. Through the low ground the tops of the piers were finished at El. +17, about 6 ft. above high water, to protect the steel from floating ice cakes, which are liable to occur simultaneously with high water conditions.

Main Piers—Reinforced-concrete caissons were considered in the original estimates for the main piers, but the contract was awarded on steel working chambers. Later, however, at the request of the contractor this design was changed to one of reinforced concrete. The construction and sinking of these caissons, which worked out very satisfactorily, are of especial interest.

The location of the west pier was just behind the west dike, and therefore on land at ordinary water stages. A platform of short timbers was first laid on

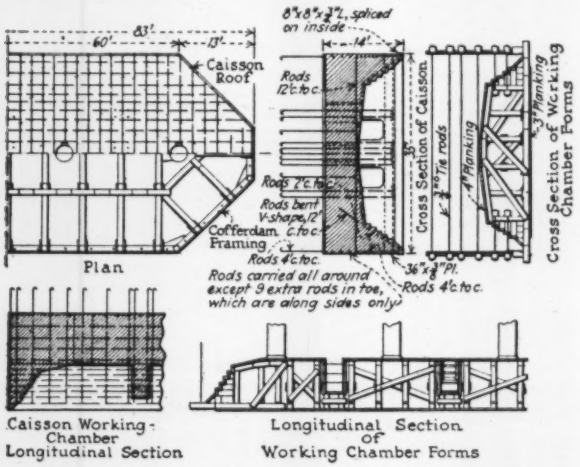

Caisson Roof
Plan
Cofferdam Framing
Rods carried all around except 9 extra rods in toe, which are along sides only
Cross Section of Caisson
Cross Section of Working Chamber Forms
Caisson Working-Chamber Longitudinal Section
Longitudinal Section of Working Chamber Forms

FIG. 3—CONCRETE CAISSON OF CENTER PIER

the sand and on this platform the steel cutting edge and forms for the working chamber were constructed, and the concrete working chamber (Fig. 3) was poured. The roof of the chamber was reinforced for the maximum weight of wet concrete which it would be required to carry, and the walls for the maximum side pressure which would be developed as sinking progressed. The side walls were, in addition, braced by concrete cross-walls. Openings for material and man shafts were, of course, provided in the roof.

After the concrete in the working chamber had sufficiently set, the forms and timber platform were removed through the shaft openings, leaving the cutting edge supported on the sand. The air locks were installed, and material excavated was hoisted in buckets, through the locks, in the usual manner. This excavation was done under air because of the presence of some stone and timber from the dike. As the sinking progressed additional concrete was poured on top, removable sectional steel forms about 5 ft. high being used.

The center pier presented a somewhat different problem, for at that point there was about 15 ft. of water. A steel sheetpile cofferdam was driven and tied together with rods. The dam was then filled with sand dredged from the river bed, to an elevation above the water level, which provided an island on which to build

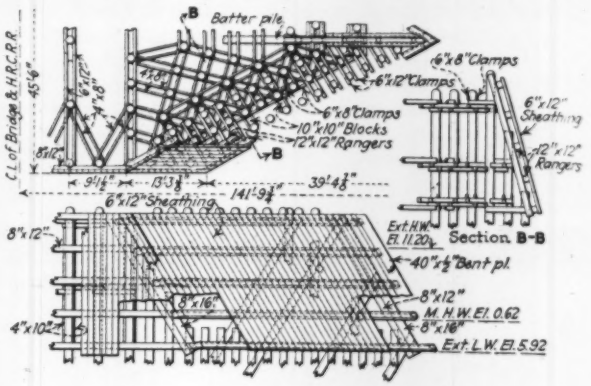


FIG. 4—TIMBER PIER FENDER

the caisson. The working chamber was constructed as for the west pier, but inasmuch as the material to be excavated was all sand, it was possible to remove it to El. —20 with orangepeel buckets passing through open shafts. When the cutting edge reached El. —20, the air locks were installed, and with an air pressure of 10 lb., the remaining material to rock was blown out through pipes embedded in the concrete.

After reaching rock, the working chambers and shafts were filled with concrete, as usual. The rock elevations were approximately —47 at the west pier and —51 at the center pier.

At the location of the east pier the rock was at El. —30, and the contractor elected to use the open cofferdam method. A steel sheetpile dam was built, heavily braced on the inside with 12x12-in. timbers, the steel sheeting being driven to close contact with the rock. This dam proved to be so tight that a 3-in. pump was able to keep it dry. The rock surface was found to be almost as level as a table.

The concrete foundations for the main piers were built to El. —9.5, about 3.5 ft. below low water; Above this elevation cofferdams were built, resting on the tops of the caissons, within which, to El. +17, a granite facing was laid consisting of courses 30 in. thick, backed with 1:3:6 concrete. Each course of granite was anchored to the concrete backing with 1¼-in. hooked rods placed in recesses at the joints, and in addition the stones were anchored together by 1-in. clamps set in the top surfaces, and leaded where exposed to the weather.

The original contract plans contemplated a granite facing for the entire height of the piers above the foundations but this was later modified to reinforced-concrete construction above El. +17, as it was feared that it would be difficult to obtain such large quantities of granite in the time required. A considerable saving in money also resulted. The concrete mix was 1:2:4 with ¾-in. square reinforcing rods spaced 4 ft. in both horizontal directions through the body of the pier, the layers of rods being spaced 4 ft. apart vertically. Around the faces of the piers the rods were spaced 2 ft. vertically and in addition vertical rods were used at 2-ft. spacing.

Horizontal grooves (rustications) 3¾ in. wide and 1⅞ in. deep were formed in the vertical faces of the piers, varying in spacing from 2 ft. 9 in. at the bottom

to 2 ft. at the top. This was done to break up the great expanse of plain concrete surface which would otherwise have resulted, and to give points where such construction joints as might prove necessary could be located without marring the appearance of the piers. The tops of the piers are capped with double copings, the lower being 2 ft. thick and the upper 3½ ft. thick, with projections of 6 and 9 in. respectively. The ends were rounded. This treatment resulted in exceptionally fine looking piers.

In the design of the piers, the stability parallel to the axis of the bridge was investigated for an assumed live-load of 6,500 lb. per lin.ft. on one track of the longer span supported, a braking force of 20 per cent of this load, a wind pressure on the superstructure, live-load, and pier of 30 lb. per sq.ft. acting at an angle of 30 deg. with the axis of the bridge, the vertical dead-load, and the eccentricity of the superstructure loads. This combination gave the most severe overturning effect. Under these loads, the resultant line of pressure came within the middle third at the top of the foundation, but slightly without at points above, where, however, there was ample steel reinforcement to provide for the slight calculated tensile stress. The compressive stress was moderate under all conditions of loading, reaching a maximum of 225 lb. per sq.in. under the loading described. The eccentricity of the superstructure concentrations on the piers was made a minimum by arranging the locations of the bearings to give a resultant load as nearly central as possible.

The east and west piers were similar in design to the center pier but are a little smaller in horizontal dimensions.

In compliance with the government requirements, timber pile fenders equipped with the customary channel lights were built around the center and east river piers, extending about 100 ft. beyond the ends of the piers, both upstream and downstream, their purpose being to protect river craft from possible damage. The construction of the fenders is shown by Fig. 4. It will be noted that the noses are heavily braced, and protected by a bent steel plate, as they will be called upon to resist shock from floating ice as well as from boats and scows.

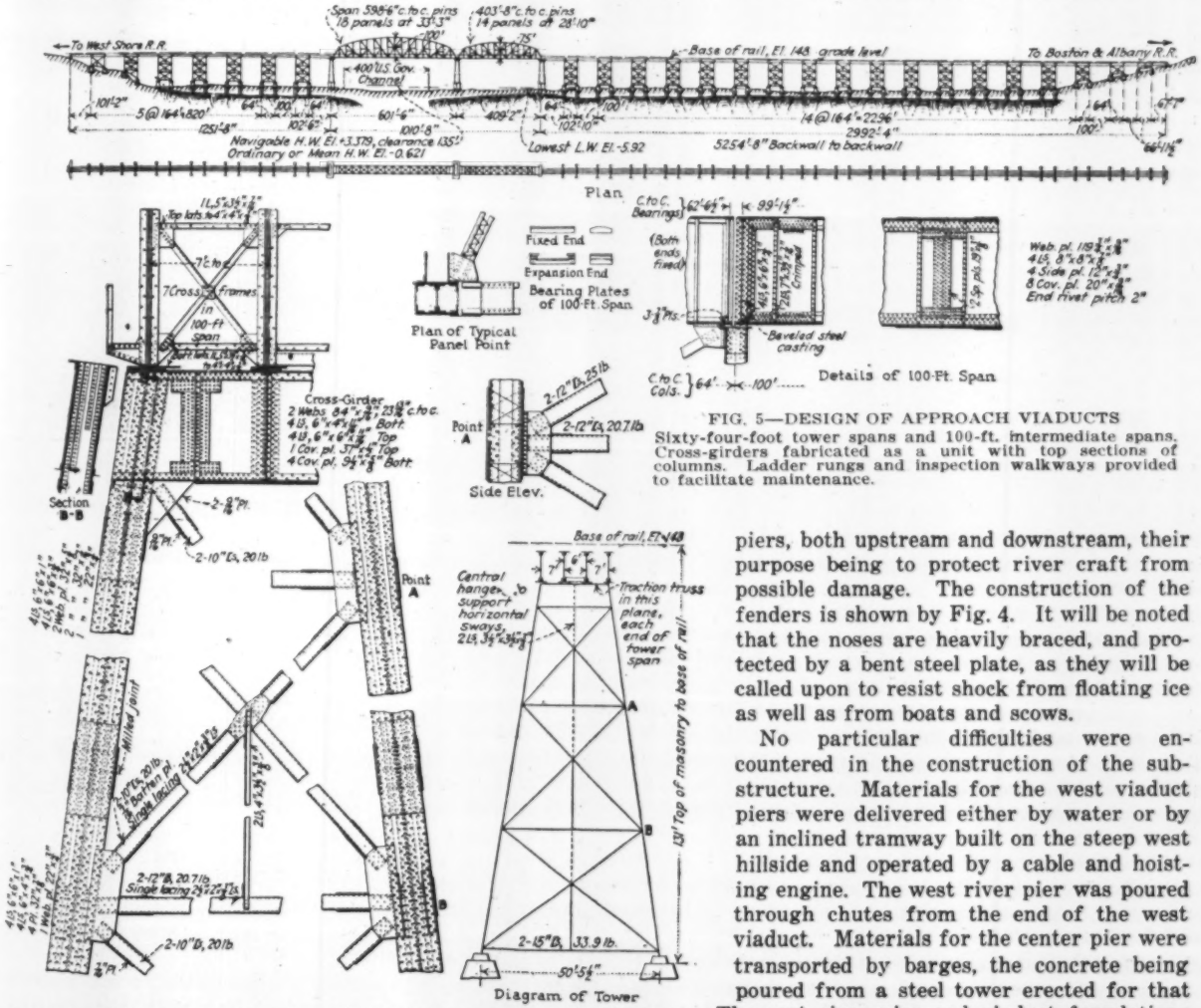

To West Shore R.R.
Span 598'6" c. to c. pins 18 panels at 33'3"
403'8" c. to c. pins 14 panels at 28'10"
400' U.S. Gov. Channel
Base of rail, El. 148, grade level
To Boston & Albany R.R.
5@164'=820'
14@164'=2296'
2992'4"
Navigable H.W. El. +3.379, clearance 135'
Ordinary or Mean H.W. El. -0.621
Lowest L.W. El. -5.92
5254'8" Backwall to backwall
Plan
Fixed End
Expansion End
Bearing Plates of 100-Ft. Span
Plan of Typical Panel Point
Beveled steel casting
Details of 100-Ft. Span
7 Cross Frames in 100-ft Span
Cross-Girder
Section B-B
Point A
Side Elev.
Base of rail, El. 148
Central hanger to support horizontal sways
Traction truss in this plane, each end of tower span
137' Top of masonry to base of rail
Diagram of Tower

FIG. 5—DESIGN OF APPROACH VIADUCTS

Sixty-four-foot tower spans and 100-ft. intermediate spans. Cross-girders fabricated as a unit with top sections of columns. Ladder rungs and inspection walkways provided to facilitate maintenance.

No particular difficulties were encountered in the construction of the substructure. Materials for the west viaduct piers were delivered either by water or by an inclined tramway built on the steep west hillside and operated by a cable and hoisting engine. The west river pier was poured through chutes from the end of the west viaduct. Materials for the center pier were transported by barges, the concrete being poured from a steel tower erected for that purpose. The east river pier and viaduct foundations between the river and the east hillside were reached by sidings from the New York Central main-line tracks, and the hillside foundations by an inclined tramway. Parts of the main piers were poured during winter weather, being protected by tarpaulins and kept warm by steam coils.

Viaduct Superstructure

Early estimates for the viaducts were based on an open timber deck. In the final design this type of floor was discarded for reinforced-concrete ballasted floor. The bridge will carry primarily through freight traffic, a considerable part of which will consist of refrigerator cars. The effect of salt brine drippings from such

equipment on exposed steel is very destructive, and entails heavy maintenance expense in repairs to corroded parts. Such repairs to girders and columns of a high viaduct would be especially serious because of the expensive falsework which would have to be erected to maintain traffic during the progress of such repairs, or the delay to train service which would result from single-track operation. Also the considerable length of the structure would have aggravated this condition. These almost certain results led to the adoption of the permanent type of deck, more expensive in first cost but least expensive in probable ultimate cost.

With some modifications, the viaducts were designed in conformity with the New York Central Lines Specifications for Steel Railroad Bridges, 1917, requiring Coopers E-70 loading, a tensile unit stress of 18,000 and a unit stress in compression of $16{,}000 - 70\,l/r$ lb. per sq.in., other unit stresses being in proportion. The tower spans were generally made 64 ft. c. to c. of bents and the intermediate spans 100 ft. c. to c. of bents. This spacing was the most economical that could be worked out to meet local and erection conditions. The tower spans were made identical, as far as possible, as were the intermediate spans, also. This resulted in a great duplication of parts, which was an attractive feature from the fabricating viewpoint.

Each bent consists of two legs battered about 1½ in. in 12 in., with a double-web cross-girder on which are supported the two inside lines of track girders, the outer track girders being supported directly on the columns. The towers are braced longitudinally for braking force and transversely for wind and live-load on one track. The bracing was made in three vertical stories or panels. Each diagonal of a panel was assumed to take half the shear in that panel, the members being proportioned to act as struts. Horizontal struts were introduced at the panel points to minimize secondary stresses in the columns, and at the bases of the columns to take the horizontal component of the column stress and to hold the columns firmly in position under temperature changes. Only one bearing of a tower was made fixed, the other three having anchor-bolt holes slotted or enlarged to permit expansion. To insure as free expansion as possible without the use of rollers, which were objectionable at these points, the sliding surfaces were heavily lubricated.

In addition to the bracing mentioned, horizontal cross-frames were introduced at each panel point to prevent any possible distortion of the towers. Because of the length of these members—up to 80 ft.—light hanger angles were connected at the intersections of the horizontal braces to prevent sag, these hangers extending continuously to the bottom flanges of the track girders, where they were supported.

The cross-girders were riveted in the shop to the upper column sections, which were made of short length. This detail (Fig. 5) provided a stiff connection of the cross-girders and at the same time simplified the erection. All column joints had faced ends and in addition were fully spliced.

For simplicity of detail, and for appearance, the track girders were all made the same depth although this resulted in the use of some excess material in the webs of the tower spans. The top gusset plates of the longitudinal tower bracing were connected to the bottom flanges of the outside track girders as well as to the columns, which could not have well been done had these girders been made of less depth than the inner girders.

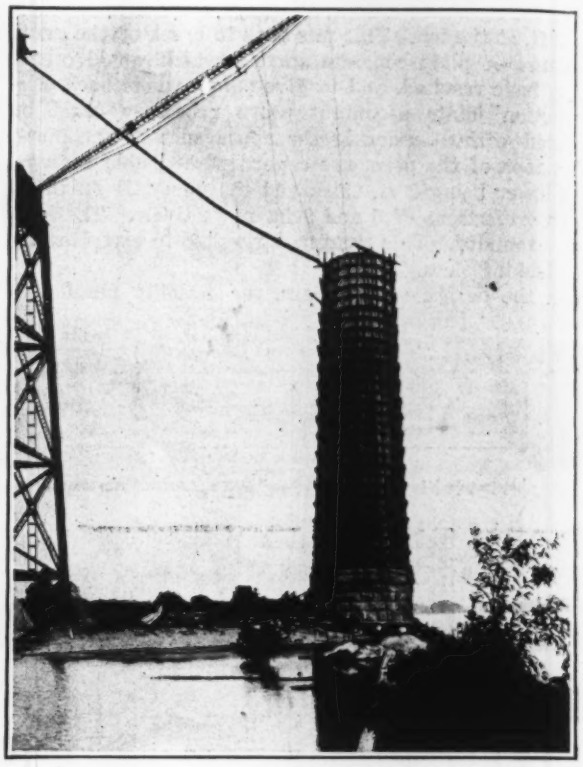


FIG. 6—WEST PIER DURING CONSTRUCTION

Expansion was provided on one end of each 100-ft. girder by sliding bearing plates, which were used in preference to rollers because of the restricted bearing space available and because of the complication of details which would have resulted from the use of rollers. To insure a central bearing, the top surfaces of the lower plates were beveled slightly front and rear, leaving a central bearing space 4 in. wide. The girders were provided with a comparatively light system of lateral bracing sufficient for erection purposes only, the heavy concrete deck being assumed to provide ample lateral stiffness under service conditions.

A somewhat unusual feature of the viaducts is the provision made to facilitate inspection and maintenance. Reinforced-concrete footwalks were provided between girders just above the bottom flanges and on brackets outside the outer lines of girders, extending the entire length of each viaduct. These walks have already proven of advantage in connection with the application of the field paint. At points on the columns where gusset or splice plates occur, ladder rungs were riveted to the plates to enable an inspector to climb over them readily, the lattice bars being used for this purpose elsewhere. Typical details of the viaducts are shown in Fig. 5.

The reinforced-concrete deck slabs were designed for a uniform live-load, including impact, of 3,600 lb. per sq.ft. Except at the east end, the slabs for each track were made independent of one another to avoid cracking in case of unequal deflection. At the east end the slab was made continuous for the entire width to provide for a crossover and the turnout to the Hudson Division connection, which had to be extended about 130

ft. onto the viaduct. To insure uniform deflection in this area, the girders (spaced 4½ ft.) were connected by stiff diaphragms at frequent intervals. The diaphragms have their top and bottom flanges connected by gusset plates to the girder flanges.

Generally, the two slabs supporting adjoining tracks were kept 3 in. apart, for drainage, and the deck surface was sloped laterally to this line of drainage. The drainage opening is covered by a perforated cast-iron cap, while under it are gutters made of 12-in. ship channels draining to 6-in. cast-iron downspouts which discharge below the bottom flanges of the girders.

The outer edges of the slabs have parapet walls to hold the ballast, these walls being extended out to support the railings. The slabs were waterproofed with two-ply asphalt-saturated cotton fabric and three moppings of asphalt. The waterproofing membrane is protected by a 2½-in. course of 1:2½:5 concrete reinforced with wire mesh. The expansion joints were made watertight by inserting transverse sheet-copper gutters anchored to the concrete and extending up the sides of the parapet walls. The tops of these gutters are protected by flat steel plates.

The railings consist of concrete posts 9 in. square spaced about 6 ft. 3 in. apart, carrying a top rail of 3½-in. gas pipe and two lower rails of 3-in. gas pipe. The pipes run through cast-iron sleeves finished on the ends with ogee collars, which were cast in place in the posts. The rather unusual size of the rails was adopted to harmonize with the general magnitude of the structure, the resulting appearance being very satisfactory. It is the writer's opinion that many large bridges have been spoiled in appearance by the use of 1½-in. or 2-in. gas pipe for railings, when such small sizes are out of proportion to the structure generally.

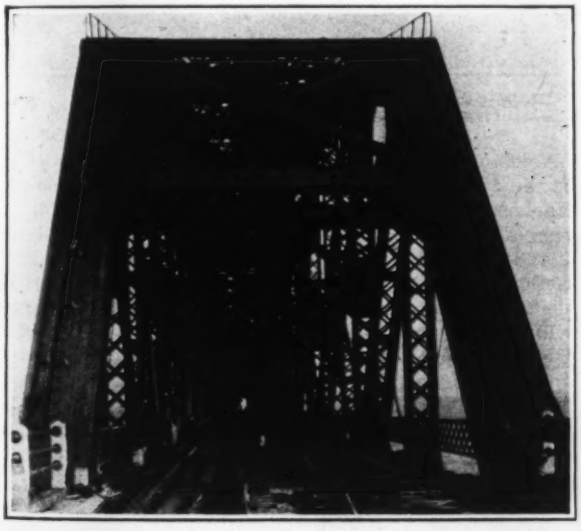


FIG. 7—END VIEW OF 600-FT. SPAN

Note heavy construction. Inspection provisions include ladder rungs on end post and hand rail along top chord.

Figs. 8 and 9 show typical details of the viaduct deck and inspection walks.

Truss Spans

While the actual truss lengths between centers of bearings were 403 ft. 8 in. and 598 ft. 6 in., the spans will be referred to by their nominal lengths—400 ft. and 600 ft. respectively.

Riveted Trusses Decided Upon—The outline diagram of the trusses on which the contract was awarded contemplated K-system webbing and eyebar bottom chords. It was thought at that time that the K-system would result in easier erection because of shorter members and would materially reduce secondary stresses, and that eyebar bottom chords would be considerably less expensive than riveted chords. In some of the early studies of details, pins had been used throughout except where reversal of stress occurred, but later, pin details were discarded, except for the bottom chords, in order to get the greater stiffness of riveted joints and because it was thought that simpler details would thereby result.

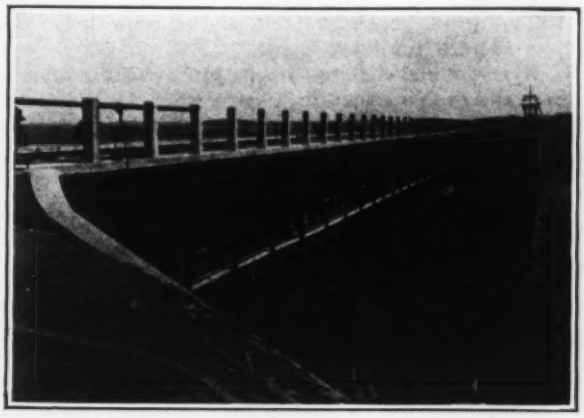


FIG. 8—DECK OF VIADUCT, WITH INSPECTION GALLERY ALONG LOWER FLANGE OF GIRDER

After bids were taken it was found that the substitution of riveted bottom chords for eyebars would cost no more per pound, the only increase being due to the extra weight of metal involved, which was not of sufficient importance to outweigh the advantages of the stiffer construction. Trusses riveted throughout were therefore adopted.

There proved to be some economy of metal in the subdivided web system adopted over the K-system, and as the contractor proposed an acceptable method of shop fabrication designed to largely eliminate secondary stresses, the K-webbing was abandoned. Subdivided panels are usually prolific of secondary stress, but the worst members in this respect—the sub-diagonals in the end panels—were eliminated by making the truss depth at the first panel point such that subdivision of the two end panels was unnecessary.

Loading—The floor systems of the truss spans were designed for the same loads and with the same unit stresses as were used for the viaducts. Because of the length of the spans, however, the loading for the trusses was reduced to Cooper's E-65, and to allow for the probable infrequency of getting maximum double-track load, this was further reduced 5 per cent. To obtain a distribution of material in the trusses which will give uniform unit stresses under a 25 per cent overload, the trusses were designed using unit stresses in tension of 16,000 lb. per sq.in. for live-load and 20,000 for dead-load, with other stresses in proportion. The resulting total weight of metal differed but little from the weight which would have been obtained by using a uniform unit stress of 18,000.

While a ballasted concrete floor would have been desirable on the truss spans as well as on the viaducts, such construction would have greatly increased the sections of the members, already large, and it would have been difficult to design the chord splices for such an increase in load without recourse to some kind of special high-strength steel, or a change in the style of chord splice desired by the contractor. In addition to construction difficulties, the cost would have been excessive. It was thought that, with special attention given to the maintenance, such repairs as may be necessary to the floor members due to corrosion in years to come will not prove insurmountable, and an open timber deck was adopted for these spans.

Members and Splices—In the proportioning of members and design of details, close contact was maintained with the contractor's engineers, so that the design would conform as nearly as possible with shop and erection conditions. This was reflected in the erection, which progressed with remarkably few troubles because of difficult connections or misfits.

The usual box sections laced on two sides, with angles turned in, were used for the truss members throughout, except that the top chords were made of two I-sections connected by a cover plate on top and with double lacing connecting the bottom flanges. Transverse diaphragms were used at intervals to hold the members square. These diaphragms were designed for the twist which would result from rolling a member on its side.

The contractor desired that there should generally be no interlocking plates at the splices because of difficulty and danger in erecting the heavy members under such conditions. Stepped joints were used with a splice plate on each side of each segment extending the full length of the splice. While this arrangement undoubtedly facilitated the erection, it produced unusually long splices—in the case of the largest—practically up to the limit of the space available. Due to the length and weight of the chord members, it was necessary to splice them on each side of the main gussets, the gusset plates with their diaphragms and connecting splice material being generally shipped and erected as independent units (see Fig. 10). This led to the utilization of the gusset plates and attached filler pieces as splice material to obtain compact and economical details.

Great care was taken in the proportioning of the material and rivets in the splices, which have areas 10 per cent in excess of the areas of members connected. The stress distribution through a splice at various sections was computed by the principle of moments. Field rivets were increased in number only 12½ per cent over shop rivets, instead of the usual 25 per cent, as with careful inspection and improved methods of driving it was believed that practically as good rivets would be obtained in the field as in the shop. However, where rivets were required to carry stress through intervening plates, additional rivets were provided.

The gusset plates were carefully investigated for strength to resist shear, for tearing out, and as beams. At points where exceptionally heavy concentrations of stress occurred, double gussets were used.

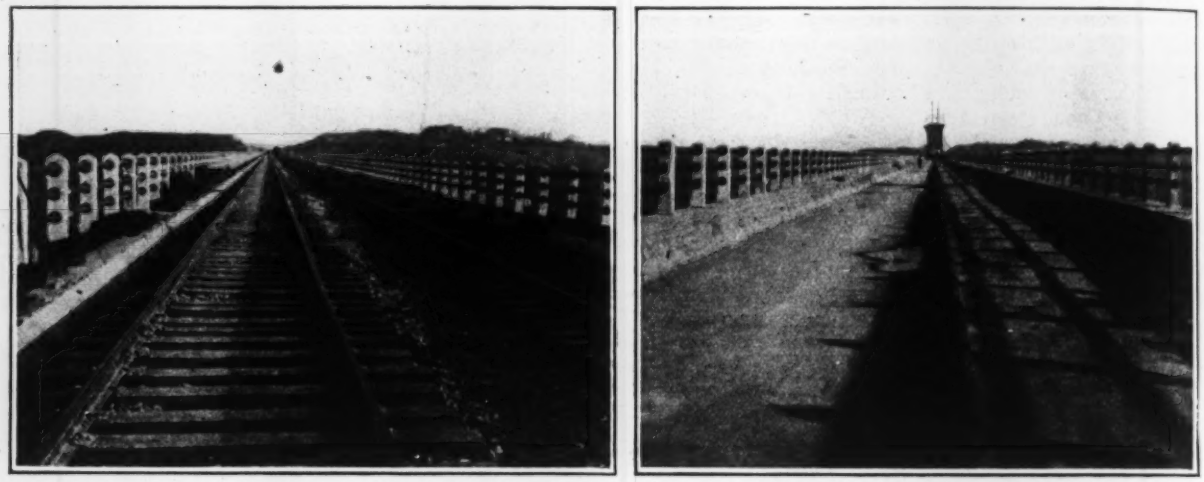


FIG. 9—CONCRETE SLAB DECK OF VIADUCT
Separate slab under each track, drainage gutter between. Heavy pipe railing with concrete posts.

Lacing and Rivets—Considerable attention was given to the design of lacing bars, particularly for the chords. Various studies were made in an effort to obtain a simple, effective and economical detail. It is believed that these objectives were realized in the use of double lacing, one system of which consists of channels with the flanges turned in, and the other of flats of the same width as the channels. This design has the smooth appearance and simplicity of fabrication of flat bars, and the channel flanges provide the necessary stiffness. On the heavier web members and the bottom chords of the 400-ft. span, which did not require such width of bar for the connections as did those for the top chords, angles were substituted for the channels.

The rivets used in the trusses were generally ⅞-in. and 1-in., but 1⅛-in. rivets were used in some of the heavier joints of the 600-ft. span, and 1¼-in. rivets in the end jacking floorbeam of the 600-ft. span. Rivets with grips exceeding 5 in. were tapered. The maximum grips were 9⅛ in. for 1¼-in. rivets, 7⅞ in. for 1⅛-in., and 7⅛ in. for 1-in. rivets.

As for the viaducts, ladder rungs were provided on large gusset plates, and care was taken throughout to make the various parts of the truss members readily accessible for inspection and maintenance. A steel ladder was attached to each end post and a light gas-pipe rail was placed on the outside of each top chord

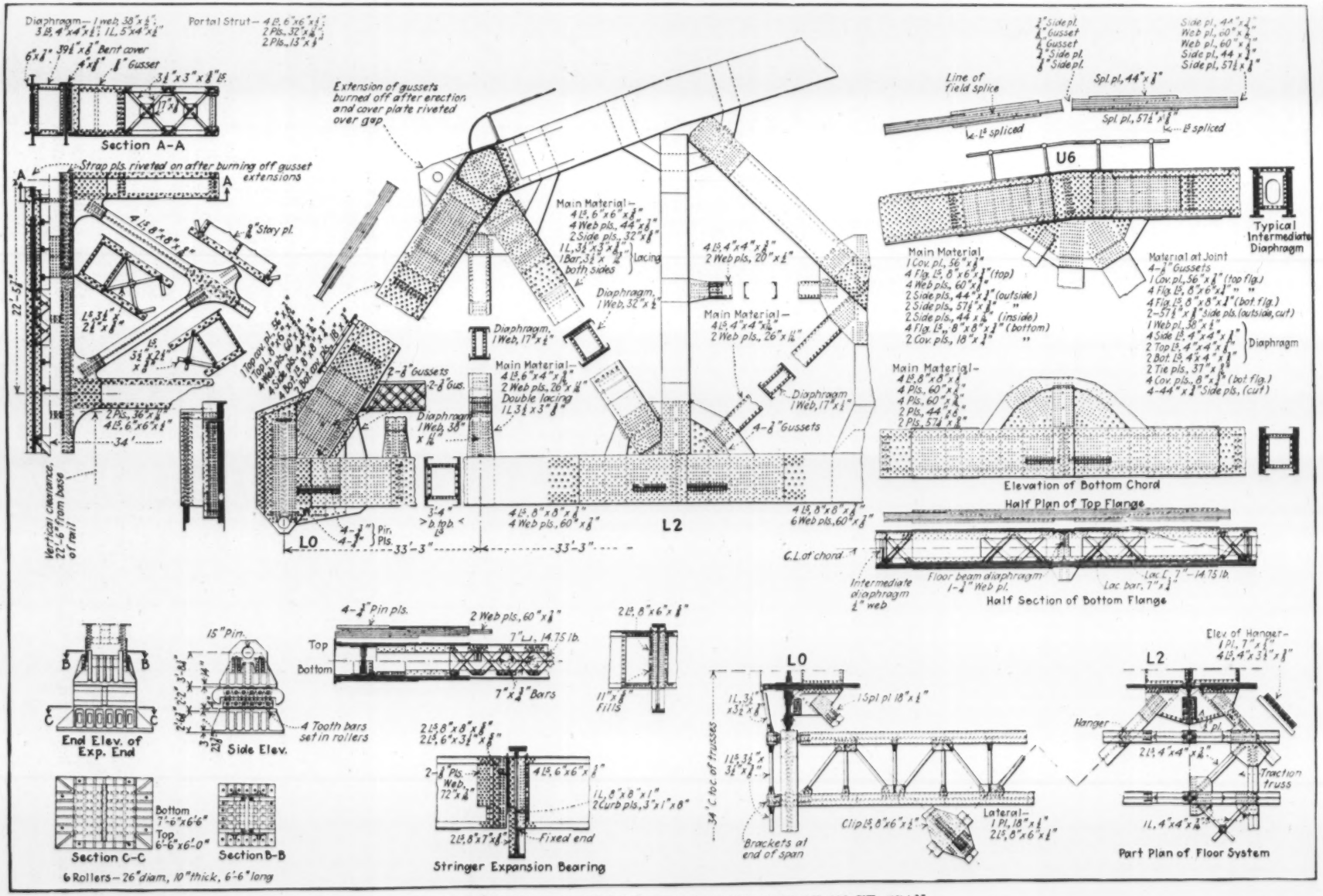

Section A-A
Strap pls. riveted on after burning off gusset extensions
Extension of gussets burned off after erection and cover plate riveted over gap
Main Material—
4 L's 6"x6"x 1"
4 Web pls., 44"x 1/2"
2 Side pls., 32"x 1/2"
1 L 3 1/2"x3"x 1/2" } Lacing
1 Bar, 3 1/2"x 1/2" both sides
Diaphragm, 1 Web, 32"x 1/2"
Diaphragm, 1 Web, 17"x 1/2"
Main Material—
4 L's 6"x4"x 1/2"
2 Web pls., 26"x 11/16"
Double lacing
1 L 3 1/2"x3"x 3/8"
2-7/8" Gussets
Diaphragm 1 Web, 38"x 11/16"
4 L's 8"x8"x 1"
4 Web pls., 60"x 1/2"
L0
L2
4 L's 8"x8"x 1"
6 Web pls., 60"x 1/2"
4-7/8" Pin Pls.
33'-3"
34'
22'-5"
Vertical clearance, 22'-6" from base of rail
Portal Strut— 4 L's 6"x6"x 1"
2 Pls., 32"x 1/2"
2 Pls., 13"x 1/2"
Diaphragm— 1 web 38"x 1/2"
3 L's 4"x4"x 1/2"; 1 L 5"x4"x 1/2"
6"x 1/2" 39 1/2"x 6" Bent cover
4"x 1" 4" Gusset
3 1/2"x3"x 1/2" L's
Stay pl.
L's 3 1/2"x 2 1/2"
L's 5"x3 1/2"x 5/8"
2 Pls., 36"x 1/2"
4 L's 6"x6"x 1"
Top pl. 56"x 1/2"
Top L 6"x6"x 1"
4 Web pls. 60"x 1/2"
4 Side pls. 44"x 1/2"
4 Bot. L's 8"x8"x 1"
Bot cov. pls. 60"x 1/2"
Main Material—
1 Cov. pl., 56"x 1/2"
4 Flg. L's 8"x6"x 1" (top)
4 Web pls., 60"x 1/2"
2 Side pls., 44"x 1/2" (outside)
2 Side pls., 57 1/2"x 1/2" "
2 Side pls., 44"x 1/2" (inside)
4 Flg. L's 8"x8"x 1" (bottom)
2 Cov. pls., 18"x 1/2" "
Material at Joint
4-1/2" Gussets
1 Cov. pl., 56"x 1/2" (top flg.)
4 Flg. L's 8"x6"x 1/2" " "
4 Flg. L's 8"x8"x 1" (bot flg.)
2-57 1/2"x 1/2" Side pls. (outside, cut)
1 Web pl. 38"x 1/2"
4 Side L's 4"x4"x 1/2" } Diaphragm
2 Top L's 4"x4"x 1/2"
2 Bot. L's 4"x4"x 1/2"
2 Tie pls., 37"x 1/2"
4 Cov. pls., 8"x 1/2" (bot flg.)
4-44"x 1/2" Side pls., (cut)
Typical Intermediate Diaphragm
Line of field splice
Spl pl, 44"x 1/2"
Spl pl, 57 1/2"x 1/2"
L's spliced
U6
Elevation of Bottom Chord
Half Plan of Top Flange
C.L. of chord
Intermediate diaphragm 1/2" web
Floor beam diaphragm 1-1/2" Web pl.
Lac bar, 7"x 1/2"
Lac L, 7" — 14.75 lb.
Half Section of Bottom Flange
End Elev. of Exp. End
15" Pin
Side Elev.
4 Tooth bars set in rollers
4-1/2" Pin pls.
2 Web pls., 60"x 1/2"
7" L.J., 14.75 lb.
Top
Bottom
7"x 1/2" Bars
2 L's 8"x6"x 1/2"
11"x 1/2" Fills
Section C-C
Bottom 7'-6"x6'6"
Top 6'-6"x6'-0"
Section B-B
6 Rollers — 26" diam., 10" thick, 6'-6" long
2 L's 8"x8"x 1"
2 L's 6"x3 1/2"x 1/2"
2-1/2" Pls. Web 72"x 1/2"
4 L's 6"x6"x 1/2"
1 L 8"x8"x 1"
2 Curb pls., 3"x 1"x 8"
2 L's 8"x7"x 1/2"
Fixed end
Stringer Expansion Bearing
L0
1 L 3 1/2"x 3 1/2"x 1/2"
15 Spl pl 18"x 1/2"
1 L's 3 1/2"x 3 1/2"x 1/2"
34'-0" c to c of trusses
Brackets at end of span
Clip L's 8"x6"x 1/2"
Lateral— 1 Pl., 18"x 1/2"
2 L's 8"x6"x 1/2"
L2
Elev. of Hanger— 1 Pl., 7"x 1/2"
4 L's 4"x3 1/2"x 1/2"
Hanger
2 Pl.
2 L's 4"x4"x 1/2"
Traction truss
1 L 4"x4"x 1/2"
Part Plan of Floor System

FIG. 10—TYPICAL MEMBERS AND CONNECTIONS OF 600-FT. SPAN

extending its full length. This rail was purposely made light so that it would be inconspicuous.

Floor expansion points were provided at floorbeams about 200 ft. apart, with trussed horizontal bracing midway between to take the braking force to the trusses.

Sections of truss members and various typical details are shown in Fig. 9.

Signal Lines—Signal, telegraph and telephone cables, and cables serving the channel lights and fog bells, are supported on brackets attached to the outside girders of the viaducts, and to the outside of the trusses, just above the bottom chords. They are thus accessible and protected from injury.

Fabrication

Eliminating Secondary Stresses—While the usual shop methods were followed in the fabrication of the viaducts, in the case of the trusses an effort was made

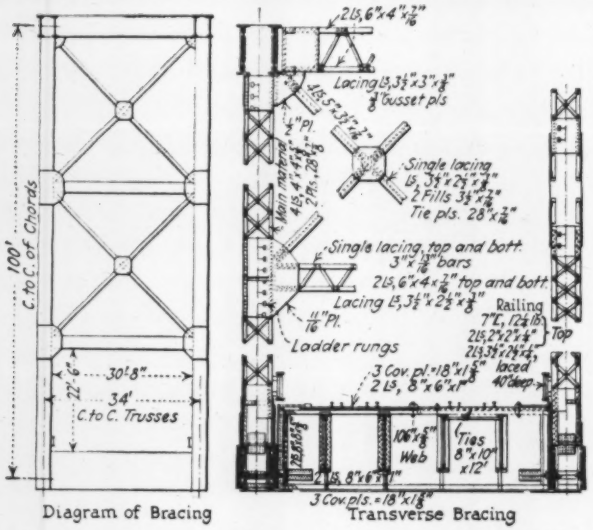


FIG. 11—FLOORBEAM AND SWAYFRAME OF MAIN SPAN

to partially eliminate secondary stresses in fabrication. This was done by drilling the holes in connections at such angle with the center lines of the members that in erection reverse secondary stresses would be produced in the various members which would disappear under half live-load plus half impact, with the bottom chords horizontal. In other words, in the erected position with full camber, the center lines of connecting holes would form small angles with the geometrical center lines for that position, thus producing a slight mismatching until the members were drifted or jacked into position, when reverse bending would be set up. The camber diagrams were figured for dead-load plus an assumed live-load of 4,400 lb. per lin.ft. on each track, which was a little more than one-half of the live-load and impact. The lengths of the various members were determined by the amount of lengthening or shortening which would occur under this loading. In computing the changes in length of the various members the gross areas were used, increased by certain percentages for details. These percentages varied from 7 for the heavy chords to 31 for the light horizontal struts. Another diagram was prepared with the bottom chord horizontal, and the angles formed by the various members were calculated. The members were fabricated to the lengths of the camber diagram, but the connecting holes were drilled to the angles given by the second diagram.

The 400-ft. span was the first to be fabricated. As the truss members were riveted they were removed to the reaming yard, where the web members were assembled on skids to the bottom chords at the angles of the uncambered diagram, and the connecting holes were drilled. These parts were then dismantled and the web members were reassembled for the purpose of drilling the center connections, after which the web members were again assembled to the top chords and the top connections drilled. The floorbeam connections were reamed to metal templets.

Every care was taken to assemble the members to correct angles, which were laid out with a transit and checked by triangulation. Some difficulty was at first experienced in assembling the chord members, due to the fact that clearance had been left between the ends of the web plates, so that there was no definite stop to fix the position of the member. This was corrected in members fabricated later, by planing the ends of one pair of abutting plates at each joint to exact length. It was, of course, impracticable to face all abutting parts because of the lapped or stepped design of the splices.

While the efforts made to eliminate secondary stresses were undoubtedly in the right direction, the differences in angles of the cambered and uncambered positions of a truss are so small and such extreme accuracy is necessary to measure them, that it is a question whether the full results desired were realized. No other provision was made for secondary stresses, although some calculations were made to determine how extensive they might be. On the 600-ft. span, straingage points have been established around some of the main joints in an effort to measure such stresses as may be produced by dead-load. These measurements will give a check on the results obtained by the fabrication methods.

Yard Assembly Reduced—The assembly and drilling of the 400-ft. span consumed so much more time than had been anticipated that, for the 600-ft. span, a change in the method of drilling connection holes was imperative in order to avoid serious delay in the completion of the work. It was decided to assemble only the chords, and the end post, first diagonal and first two vertical members at each end, drilling the remainder of the connections to metal templets. This made possible the completion of most of the web members in the shop instead of in the open reaming yard, which expedited the work not only because it eliminated a great deal of assembling of members but also because the 600-ft. span was largely fabricated during winter weather.

Care was taken to secure the greatest degree of accuracy possible and the results proved to be just as satisfactory as those obtained by the complete assembly of the 400-ft. span trusses. Each group of holes for both spans matched perfectly in the field. It appears from this experience that with proper care, such connections can be accurately reamed to templet at considerably less expenditure of time than by complete assembly of members.

[*The erection of the bridge superstructure will be described in a second article.*—EDITOR.]

Concrete Pipe Line and Flume for Factory Waste Water

Riffles in Flume Aid Cooling Effect—Deep Trench for Pipe—Clean Waste and Storm Water Go to City Reservoir

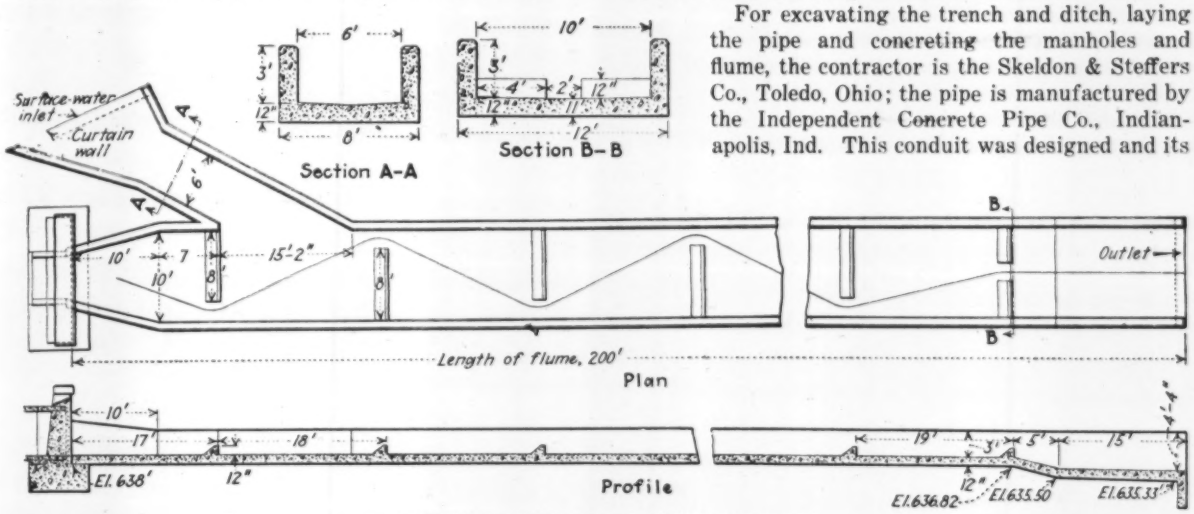
TO CARRY clean waste water and storm water from its corn products plant to Lake Decatur, the A. E. Staley Manufacturing Co., Decatur, Ill., is building a conduit 7,700 ft. long, comprising 4,300 ft. of 60-in. reinforced-concrete pipe, 200 ft. of open concrete flume with bottom riffles to agitate the water and 3,200 ft. of ditch to the lake. At present this plant uses for cooling purposes about 10 m.g.d. of water taken from the lake by the company's pumping station, but as plans are being prepared for extensive enlargement of the plant the conduit is designed to care for 50 m.g.d. from the plant and also the storm-water runoff from 75 acres of the company's property. This runoff was figured on the basis of a continuous rainfall of 2 in. per hour for a 24-hour period with the entire drainage area impervious, although roofs, paved roads and other impervious surfaces represent only approximately 30 per cent of this area. Since the lake is the source of the city's water supply, the conduit will receive only clean waste water, such as that from the condensers.

A 60-in. pipe line was decided upon for the main part of the conduit, with a grade of 0.2 per cent for the first 2,500 ft., then 0.9 for 1,000 ft. and 0.6 per cent for the remaining 800 ft. A deep trench will be required for the entire length, averaging 17 ft. for the first 1,200 ft. and then 24 ft. for 1,300 ft. with a maximum 31-ft. cut 250 ft. long. Beyond this the average cut is 12 ft. This pipe, in 4-ft. lengths with socket joints, has extra heavy reinforcement of wire mesh on account of the depth of cover. It is manufactured along the trench, and each piece is left to cure for thirty days before being laid.

A concrete headwall forms the connection between the pipe line and the flume, the latter being 10 ft. wide and 3 ft. deep, with a grade of about 0.5 per cent. In order to check the velocity of the water and to agitate it as an assistance to the cooling effect, riffles are formed in the bottom, extending nearly the entire width from opposite sides alternately, as a series of baffles. The bottom is sloped to a wavy low point extending between the ends of the riffles, as shown, this low point being 1 in. below the normal level of the bottom. A side entrance to the flume takes care of surface drainage from the north. Beyond the flume outlet is the ditch, with sides sloped 1 on 1½ and a 10-ft. bottom having a grade of approximately 0.8 per cent.

For the pipe conduit, a trenching machine cuts a trench 78 in. wide in hard yellow clay underlaid with hard blue clay; the pipe is handled and set with a revolving crane on crawler tractors and the trench is then filled by a backfilling machine. Skeleton bracing is sufficient through most of the trench, but in sand pockets 2x6-in. wooden sheeting is used with 6x6-in. frames.

For excavating the trench and ditch, laying the pipe and concreting the manholes and flume, the contractor is the Skeldon & Steffers Co., Toledo, Ohio; the pipe is manufactured by the Independent Concrete Pipe Co., Indianapolis, Ind. This conduit was designed and its construction supervised by the engineering department of the Staley Manufacturing Co., under the direction of J. M. Weir, chief engineer.



FLUME HAS RIFFLES FOR COOLING WATER

Property-Owners Seek to Unhold Zoning

In an effort to dissuade the Board of Zoning Appeals of Newark, N. J., from passing favorably on an application to admit a 20-family apartment house into a restricted residential district the attorney for those seeking to protect their homes, says the Newark *News* editorially, seems to be trying "to meet the decisions of the court" [State Court of Errors and Appeals] by establishing a direct relationship between zoning and the "public welfare, safety, health and morals." Continuing, the *News* says: "To that end Mr. Stickel has marshaled an engineer of the Water Department to testify as to insufficient water, a fire battalion chief to tell of the possible fire menace, a police captain to discuss the necessity for increased police protection and possible relationship between apartment houses and social vice, the superintendent of buildings to testify upon the hazard of blighted residence districts, a second city engineer and a sanitary inspector of the Health Department to provide vital testimony relative to sewerage facilities. An assistant superintendent of schools described the congested condition of the schools of the locality and talked upon the probability of further overcrowding that would be expected with the erection of multi-family residences in the district. Finally a Tax Board surveyor stated that the district now under zoning is made up of one- and two-family houses."

Loss of Head in Closely Baffled Mixing Basin

Determination of C in Chezy Formula for Various Rates of Flow at Water Filtration Plant of Greensboro, N. C.

BY C. W. SMEDBERG
Engineer-in-Charge Water Filtration Plant, Greensboro, N. C.

THE NEW 6-m.g.d. water filtration plant of Greensboro, N. C., recently placed in operation, has incorporated in its design a closely baffled mixing basin of the "around the end" type. The loss of head through the basin, together with the coefficient *C* of the Chezy formula, at various rates of flow has been the subject of investigation to secure data for future plant extensions, which would also be of interest and value to engineers engaged in similar work.

The mixing basin is of concrete, 60 ft. 10½ in. x 28 ft. 6 in. in plan, with an overall depth of 11½ ft. (see Fig. 1). Two dividing walls within the basin form three equal compartments, in which are placed the baffle walls. Five 12x24-in. openings connect the compartments. Baffle walls of reinforced concrete, 2 in. in thickness and spaced on 16-in. centers, extend to within 12 in. of the top and alternately within 14 in. of the exterior and dividing walls of the basin.

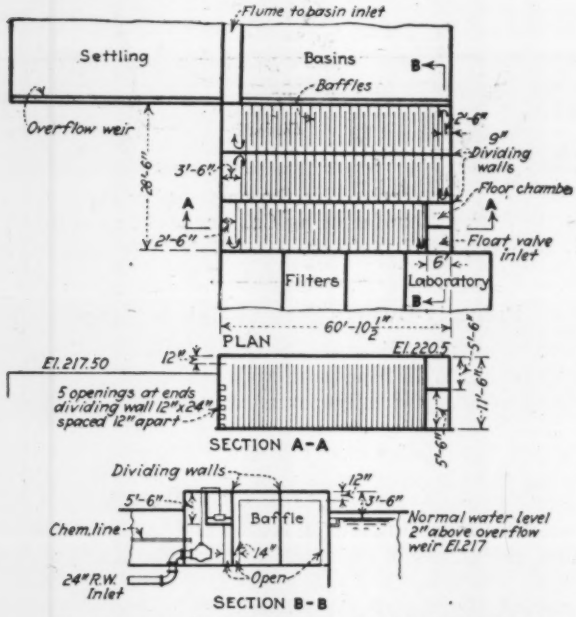


FIG. 1—PLAN AND SECTIONS OF MIXING BASIN

Entrance of the water to the basin is through a 24-in. cast-iron pipe line, controlled by a float valve, the float chamber of which is connected by equalizing lines to the settling basin and maintains a constant head on the overflow weir of the settling basin. The entrance to the mixing basin proper is through a 1 ft. 2 in. x 5 ft. 6-in. opening directly beneath the float chamber. The water then passes around the baffle walls of each compartment throughout its entire length, a distance of approximately 1,061 ft., to the outlet, whence it is carried by a 3x3-ft. concrete flume to the inlet of the settling basin. The basin is designed for a mixing period of 20 minutes at the full plant capacity of 6 m.g.d., with an available head of 2½ ft., allowing no freeboard at the inlet baffle.

The float valve, during the investigation, was blocked up in the wide-open position, and a constant rate of flow was maintained by a hand-operated valve. A Venturi meter recorded the flow. The loss of head for each rate of flow was obtained from the difference in the depth of the water below the top of the basin walls at the inlet and outlet and corrected for a slight difference in wall elevation. When the loss of head and rate of flow were known, the coefficient *C* was computed from the basin dimensions. Sufficient time was permitted to elapse between changes in rates of flow to assure normal working conditions before measurement was made. Fig. 2 gives the loss of head for each of the rates of flow, together with its corresponding coefficient *C*, each point representing the average of 4 to 10 measurements at different times during the period covered by the investigation.

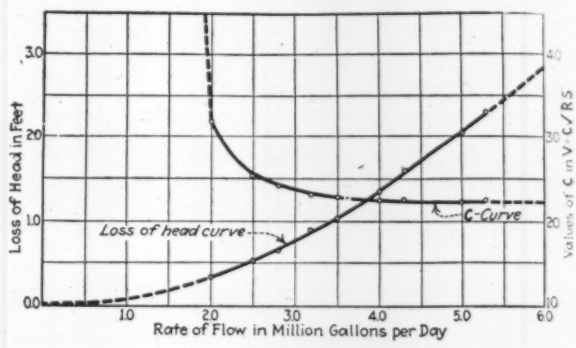


FIG. 2—RELATION BETWEEN LOSS OF HEAD AND C IN CHEZY FORMULA IN MIXING CHAMBER CHANNELS

The result of the investigation indicates the necessity of providing additional head in order to operate the basin at full plant capacity. The value of *C* for the various rates is of interest in its apparent approach to a straight line in the higher flows, and should prove important to designing engineers in establishing the head for other basins, but it should be kept in mind that it can only be applied directly to basins of similar design.

Commission Rules Concerning Flow Data

Stream flow and other data which have been compiled by an applicant under the Water Power Act will not be made available to another applicant for the same rights even if the rights granted the first applicant should be allowed to lapse, according to a decision of the Federal Power Commission. This decision was the result of a situation which arose recently when the holder of a preliminary permit was not in a position to apply for a license at the end of the legal limit of his permit and a prospective applicant for a preliminary permit covering the same site took the position that he should not be required to undergo the expense incident to duplicating the information already in the hands of the commission. The commission ruled that such data will be turned over to new applicants only when the former applicant definitely abandons the project. In most cases the earlier applicant expects later to qualify for a license and therefore to make use of the data which he has accumulated at some later date.

Form Selection and Formsetting for Concrete Roads

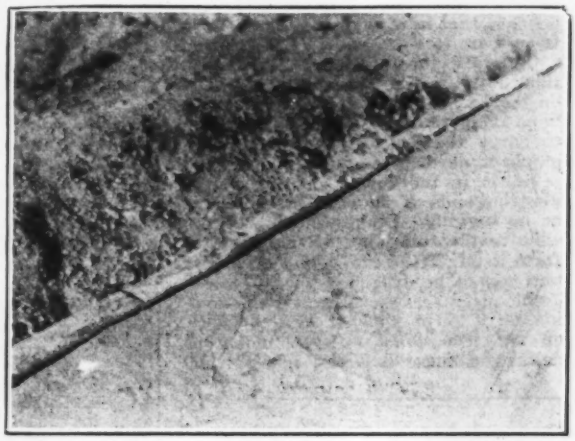
Smooth Roads Closely Related to Good Formwork Rigid Forms and Solid Supports Essential Setting Methods Important

By C. N. Conner
Construction Engineer, North Carolina State Highway Commission, Raleigh, N. C.

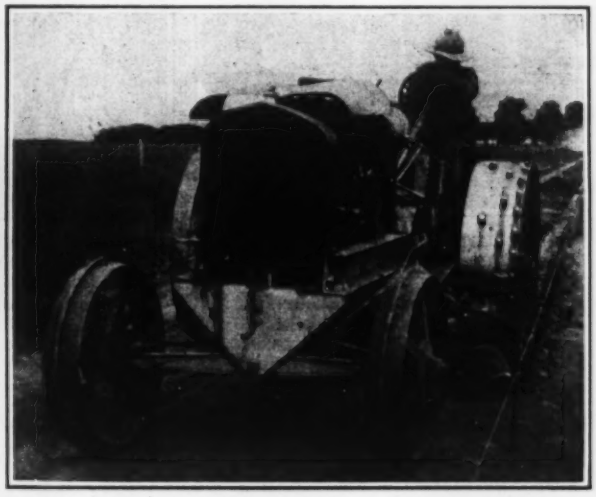
Abstract of a paper presented at the meeting of the American Road Builders' Association in Chicago, Jan. 5-9, 1925.

FORMS for concrete roads have not been given the consideration they should receive. The concrete may be properly proportioned, mixed, placed, and finished, but, if the forms are not to line and grade the road surface is uneven. Only in recent years have highway departments come to appreciate that the forms play this important part in shaping the road surface and contractors have begun to keep their equipment in proper condition.

At the present time there is wide divergence in the specifications of the several states. In some the weight of forms is specified and in others the weight per foot; others specify the width of base, number of stakes to the rail, and complete details. In the majority of states wood or steel forms are optional with variance as to weight (of steel) or thickness (of wood).



A FORM TOP WHICH DOES NOT MAKE A SMOOTH ROAD



HAND DIGGING FORM TRENCH, NORTH CAROLINA (LEFT); MACHINE DIGGING (RIGHT)

Three states specify wood forms with no reference to steel forms (Nevada, Minnesota and Washington). It is the practice in Washington to leave the wood form in place. Four states definitely prohibit the use of wood forms (Delaware, Maine, Maryland and Virginia). Fifteen states in addition to the four previously mentioned specify steel forms (Connecticut, Georgia, Illinois, Indiana, Michigan, Missouri, Nebraska, New Jersey, New Mexico, North Carolina, New York, Ohio, Pennsylvania, Rhode Island and Vermont). Of these, four mention that wood forms will be allowed on curves (New York, Pennsylvania, Connecticut and North Carolina).

Weight is named in the specifications of eight states as follows, in pounds per foot: Delaware 8, Indiana 9, Michigan 10, New Jersey 7, New York 6½, North Carolina 7-10, Pennsylvania 8-9, Virginia 8. It is assumed that in other states this question is left to the engineer. In respect to the thickness of wood forms a minimum of 2 in. is allowed in twenty states, of 2¾ in. in one state and of 3 in. in four states.

A form could be made of steel ¼ in. thick, and attachments added to it to bring its weight up to the required weight per foot. Such a form while meeting the specifications would not give the service, would not stand the rough handling, and would be reduced to scrap in short order, leaving a poorly built road behind; therefore, the specifications regulating weight are important. The thickness of steel used should be specified, as well as the base of the form, number of stake pockets, length of the rail sections and width of the tread flange.

Steel road forms should not in general be made of steel lighter than ⅜ in. regardless of the shape of the section. A rail made of material lighter than ⅜ in. will not give good service and will not survive the rough treatment in use and in handling on the average road job where heavy finishing machines and subgraders are used, and the man with the 10-lb. sledge is ever present.

The height of forms should be equal to the required depth of the pavement at its edge. It is of course possible to use a form of greater depth but extra labor is generally required to get the base down to grade and the contractor runs the risk of laying too great a depth of pavement. If the form is not of sufficient depth it is possible to support it on planks of metal but again extra labor is involved and the added weight makes handling difficult. The result is that most engineers require exact depth.

The base width of a form should be sufficient to carry the weight of all machines, including impact, to the subgrade without settlement. Some newly prepared or moist subgrades will not support without settlement more than 1,000 lb. per square foot. By knowing the weight of a machine, one can readily calculate what load per square inch reaches the subgrade. To eliminate all possibility of depressions, the base flange has been increased from 2 in.

to 3 in.; later from 3 in. to 4 in., and later from 4 in. to 6 in., so that now modern road forms generally have a base from 4 in. to 6 in. wide.

Generally the top flange is not less than 1½ in. or more than 2½ in. wide. The width on the top of most forms now on the market is about 2 in. This is unnecessary and perhaps dangerous. The top width should only be sufficient to carry the finishing machine but the depth should be ample to develop the web strength.

Joints in the forms should be designed to connect the abutting ends of the rails neatly and securely, so there will be no sagging. Stakes should be inserted as close as possible to the rail joint. Regardless of the strength of the form itself, if the connecting device is weak the entire system cannot be depended upon.

One often sees pictures of men standing on a form joint or a great mass of pig iron piled on the joint, but neither of these is a test nor do they even approximate the loads or stresses to which forms are often subjected in the field. A hard blow from a 10- or 16-lb. sledge will do more damage than the weight of 10 or 16 men; the weight of a finishing machine, bouncing over a ¼-in. stone is just as bad, especially at a joint. A hard wallop from a truck wheel or a subgrader will put a form out for life.

FORM SETTING TOOLS AND FIXTURES

SETTING FORMS ON MINNESOTA SUBGRADE

CARRYING FORMS AHEAD IN PENNSYLVANIA

Joints on opposite sides should be staggered whenever possible.

One of the first requirements of a satisfactory staking system is to prevent the forms from overturning, settling or changing alignment. In view of the rigid requirements for a smooth road, which means that there cannot be any break in the grade line, the staking system must perform a second or double function of preventing the form from sagging or settling either at the joints or along its length. There should be not less than three stake pockets to a 10- or 12-ft. section, preferably an extra stake pocket for emergency purposes or four stake pockets per section. Two pockets should be located as close as possible to the joint, as the joint is the weakest part in the line of forms. If the joints are not held securely, the alignment of the forms is not secure, and depressions at the joints will cause waves in the finished road surface. The length of the pins will depend on the firmness of the subgrade into which they are driven; the softer the subgrade, the longer must be the pin. The connections and braces vary widely, some designs using none at all, others depend on stiffness and comparatively thin metal for the body of the form, while others use the thicker metal and the braces. In my opinion the best form and one to which roadbuilders may come later is a structural section of medium steel which will resist impact better than the soft steel special sections now in general use.

The number of forms required depends entirely upon the speed with which the concrete is poured and the specifications under which the work is done. Specifications require that forms shall be set to line and grade from 200 ft. to 500 ft. in advance of the point of placing the concrete, the average being 300 ft. Thus, as the average day's run of concrete is 500 ft. and the forms must be left in place for at least 24 hours, about 2,000 ft. of forms are usually required per paver. However, the amount required, depending on the locality, varies from 1,000 to 3,000 ft.

As important as the forms themselves are the form setter and his assistants. They should always be selected and experienced men and should not be shifted around the job but should be kept on the forms. A delay in form setting ties up the whole outfit. Good smooth work has been obtained with poor forms but the handling and permanence of this work required special skill and constant supervision, so that the labor item more than offset the cost of better materials.

Often if form is off line a husky workman picks up a 12- or 16-lb. sledge and gives the form a whack in order to get it in line. No road form is made to stand such abuse; many form setters do not know that they can accomplish the same result by striking the ground with the sledge next to the form in the direction that they want the form to move. This saves the forms and at the same time insures better alignment, better grade and smoothness.

Every surface of a concrete road slab depends on the form; under the surface because the subgrade is shaped with forms as a guide; the outside edges because they confine the concrete; the wearing surface because all finishing devices rest upon or are guided by the tops.

Much Water Power Available on Snake River

A survey of Snake River from Lewiston, Idaho, to Huntington, Ore., a distance of 187 miles, made by engineers of the Geological Survey shows that in this distance there is a fall of 1,321 ft. and sufficient flow to make possible the development of over 1,000,000 hp. of energy. The survey included a study of the divide between the Snake and Salmon Rivers. Fifteen undeveloped power sites were studied, which, with the present flow, could develop 1,430,000 hp. for 50 per cent of the time and 861,000 hp. for 90 per cent of the time. With regulated flow and complete irrigation developments 1,080,000 hp. could be developed for 50 per cent of the time and 750,000 hp. for 90 per cent of the time. One project considered includes a diversion dam on Salmon River, a tunnel to Snake River, and a dam 530 ft. high on Snake River. As this project would make possible the development in one plant of 910,000 hp. for 50 per cent of the time and 636,000 hp. for 90 per cent of the time, the site is one of the largest yet undeveloped in the country. The only site developed in this stretch of Snake River is a 12,400-hp. plant near Copperfield, Ore.

How To Keep Costs on Construction Work

Essentials of Classification of Accounts—Labor, Materials, Quantities, Costs and Records Considered—A Simple System Applicable to Large or Small Work

By A. L. Hartridge
Construction Manager, Stone & Webster, Boston, Mass.

"How We Organize and Plan Big Building Operations" was discussed by L. J. Horowitz, president, Thompson-Starrett Co., New York, in "Engineering News-Record" March 12, p. 428. The present article by Mr. Hartridge discusses methods of keeping costs on work under construction; and a third article by Beardsley Lawrence, engineer, T. Stuart & Co., on "Checking Up on Profits During Construction" will be published soon.—Editor.

Abstract of a paper delivered before a joint meeting of engineering societies at Richmond, Va.

In obtaining dependable costs on construction work the first essential is to have these costs complete. Both material and labor costs must be recorded, and indirect as well as direct items of expense. The chart gives an idea of how in one contractor's practice all items of expense on a typical construction job are gathered together, and, with quantities of work done applied to the costs, enable a complete cost statement to be readily prepared. It will be noted from the chart that ample checks of accuracy are provided as the figures are being compiled. The cost ledger on which the cost statement and all unit cost reports are based is checked monthly with the total expenditures shown on the accounting books so that all money spent is included in the costs.

The main items of interest in discussing construction costs are: (1) Labor, (2) materials, (3) quantities, (4) costs and (5) reports. They will be considered in order.

Labor—The first requisite for a good distribution of labor charges, and, for that matter, material charges, is a well-arranged classification of accounts, by which all charges can be grouped as desired. The classification to be used is a subject that well merits considerable study, inasmuch as it determines to a very great extent the satisfactory working of the cost system and the value of the cost data obtained. There are three essentials that should apply to all systems of classification:

1. The classification should be standardized; that is, once decided upon, it should be maintained the same for all jobs, and, in so far as possible, should be in such exhaustive detail that there will be no doubt where any charge applies.
2. The classification should be logical; that is, it should be arranged so that the sequence of construction is more or less maintained in the arrangement of the accounts.
3. The classification should be universally applied; that is, in estimating the cost of the work, provision for the various items should be made in accordance with the classification, so that, later on, when actual costs are obtained according to the classification they will be strictly comparable with the estimate.

The three essentials, then, of good classification of accounts are: Standardization, logical sequence and universal application.

To insure easy memorizing of a system of separate items, arrange them in some orderly sequence, so that a knowledge of the arrangement will allow the mind to proceed easily from one part of the system to the other. For this, no system lends itself to more satisfactory adaptation than the decimal system, which has the further advantage of permitting indefinite extension without becoming too cumbersome. It has been found that but little difficulty is experienced in memorizing the account numbers likely to occur at the same time during the life of a job.

Having thus decided how the labor charges are to be grouped, it becomes necessary to insure that grouping by an effective system of time-keeping. The timekeeper should be made to realize that *his chief function as far as costs are concerned is to allocate detailed charges properly*, not merely to account for the time paid for in payrolls. On a typical job the timekeeping is carried on about as follows, modifications being made where required by any special requirements of the job.

A weekly time card is prepared for each man. This is placed in proper numerical sequence in an "out" card rack provided at the timekeeper's office. When the men arrive at work they pick their respective cards and punch the "in" time by means of the time clock, dropping the cards in a box. When the men leave they remove their cards from an "in" rack, time punch them and drop them in the box. An accurate mechanical record is thus obtained daily of the beginning and finishing time of each man.

As soon as practicable after the men have checked in, the timekeeper makes a check of the men in the field. He notes down on his checking sheet the numbers of the men he finds at work and the items of work on which they are engaged. This "blind" check, as it is called, gives an independent check on the time-punched cards and prevents a man checking in by proxy or checking in and then leaving the job. Also an *additional* check on the men's time is provided. Each foreman has a foreman's report card, on which he notes the men that reported for work, and also the items of work on which they are engaged during the day.

At the end of the day the timekeeper makes up his labor distribution for the day using his field distribution sheet. As a supplement and check, he has also the foreman's report. Summarizing his daily distributions the timekeeper makes up a weekly distribution of labor. The total amount of labor thus accounted for is checked with the total of the week's payroll which has been drawn up by the accountant on the basis of time-punched weekly time cards. The amount of money expended for labor is thus accounted for in detail and *checked by three independent original records;* the time card, the field distribution, and the foreman's report.

The amount of the payroll, which has been withdrawn from the bank by check, is covered by a voucher similar in form to that explained under "Material" and has the distribution attached. It is posted in the Cost Ledger in the same manner as other vouchers, as explained later. This constitutes the time keeping routine in regard to the ordinary labor.

There are still to be dealt with, however, special items like the locomotive crew, office men, etc., and teams. Men who are paid an hourly wage, who are on the locomotive or crane crews, or in the blacksmith or machine shops are taken care of in the way described above except that the distribution of their time, which is apt to cover many accounts, is taken directly from the foreman's report. Foremen are charged to the work in proportion to the time their gangs have spent on the different classes of work.

Superintendents, office men, designing engineers, draftsmen and so on in general are charged to general expense accounts as directed by the classification. Field engineers, material clerks, timekeepers and so on are charged to a suspense account and at the end of the week the amounts accumulated in suspense are distributed to the various items of work on some definite pro-rata basis.

Teams are charged as labor and a distribution is made every day. In checking and distributing the time of the

teamsters on the field sheet the occupation of the teams is obtained. Teams, as a rule, are hired and are paid for through a separate order and voucher as detailed later on for materials. Pavement is, hence, often made a month after the teams have been used; but to permit an accurate present cost to be obtained at any time, teams are distributed on the books as though actually paid for and an order placed at the end of the month officially to account for the money involved. Each teamster is given a slip every day showing the time he has been credited with. A carbon copy of this is retained, and on this copy the distribution is made. The teamster's copy goes to the teaming contractor whose bill, based on these slips, must check with the amount with which he has been credited on the office copies of the teaming slips. A daily distribution of teaming, similar in form to the daily labor distribution, is made and from this the teaming order is classified.

Overlapping of records is permitted only where it is necessary to insure the accurate carrying forward in the scheme of the myriads of figures involved; all figures being checked as they are carried along. Manifestly it is immaterial as far as practical value is concerned whether, in the distribution, the labor cost assigned to any item is a few cents too much, or too little; but if the total labor accounted for in the cost system does not check with the amount of money actually paid, as shown by the accountant's voucher, be it ever so small an amount, there is a perhaps unwarranted but, nevertheless, unpleasant appearance of inaccuracy if not the far more serious possibility of a series of large errors that have been compensated except for a small amount.

Material — All charges for material originate in requisitions that are filled out by authorized men on the job, checked as to classification by the cost man, and approved by the superintendent. One copy of each requisition is sent to the purchasing department, one to the material man, a third being retained on the job for record. Should the order be placed by telephone, a telephone order is made out and a requisition, marked "Confirmatory," sent out as before. The purchasing department makes out an order from the requisition, generally sending one copy (white) to the merchant, one (buff) to the job office for cost records, one (salmon) to the job accounting department to check invoices with, one (pink) to the material man, one (blue) to the main office accounting department, and one (yellow) retained by the purchasing department. The job office copy is checked as to classification by the cost man. Should any change be made in the order, a memorandum of change is sent to all the above, thus insuring a complete record, as well as an indication of the disposition of all material ordered, for all parties concerned. Inasmuch as all expenditures except payroll and petty cash are covered by orders, subject to such scrutiny, the chance for waste is reduced to a minimum. Contracts are recorded exactly like the other orders.

When the material is received on the job, it is checked by the material man who fills out the material receipt in the case of a partial shipment, or a similar form on the lower portion of the pink copy of the order in the case of a complete shipment, and forwards it to the accounting department as a check against the invoice received from the merchant. The accounting department compares the merchant's invoice, required in triplicate, with the order, checks it also against the material receipt, and if it finds the invoice in all respects correct, pays the merchant by a check. The three copies of the invoice are then attached to vouchers, one copy of which (the original) is destined for the client, one (the duplicate) for the home office, and one (the triplicate) for the job record. Ultimately, when the check is returned from the bank, the duplicate receipt is attached to the original voucher and the paid check to the duplicate voucher.

The material man is now concerned only with material that has not been charged directly to the construction accounts. This includes all material which is charged to 360-Stock (perhaps to be comformable with accounting practice, this account might more properly be called stores) which comprises all material that may be charged to various construction accounts, and miscellaneous small tools.

Material and tools are then charged to construction thus:

1. Miscellaneous material is issued to the foremen upon presentation of a requisition that lists the material wanted, and the purpose for which it is required. This order slip is sent to the cost man who classifies it and sends it back to the material man for entry on the field stock cards, under "Issues."

2. Small tools are issued to the job, and are charged to the work which is principally responsible for their use, the judgment and the knowledge of working conditions possessed by the material man being assumed reliable until the monthly statement of issues properly inspected leads to a different assumption. The salvage on small tools, generally small, at the end of the job is credited proportionally against charges on the job, small tools being of such

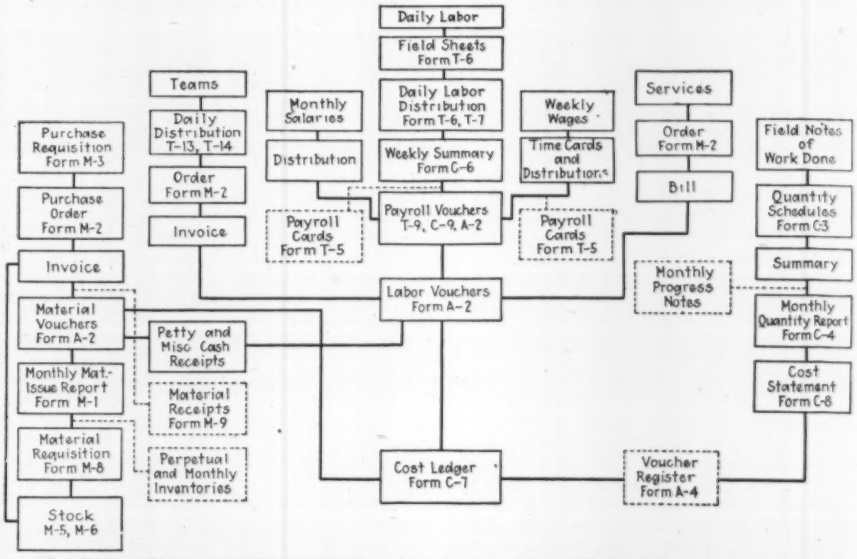


CHART SHOWING DEVELOPMENT OF COST STATEMENT FROM EXPENSE ITEMS
Dotted circles show the independent checks on the figures compiled to the respective points in the process.

quantities and varieties on large jobs that no attempt is made to keep a record of the changes accruing from each of the different kinds used. When a laborer secures a tool, he deposits at the tool house a small brass check bearing his number, and if he fails to return the tool he is charged with its value.

At the end of the month the material man has recorded all the order slips on the field stock card, and makes a monthly summary or report of the issues from stock. From day to day that department checks the balance shown on the card with the actual quantity in stock, checking a few articles one day, some others the next, and so on, thus insuring a correct perpetual inventory on which to base the monthly report of issues. The unit price it determines from a price card so that material may be properly charged out in money as well as in quantity. The report of issues is summarized according to accounts to be debited and credited, and sent to the accountant. The latter prepares from this recapitulation a journal entry transferring stock to construction accounts, and the journal entry in due course is posted into the cost ledger.

Materials like cement, sand, gravel, reinforcing steel and lumber, which are bought in very large quantities and the cost of which very materially affects the construction costs, are handled in an essentially similar manner but directly by the cost man. This is done, first, because the many incidental charges like freight, unloading, inspecting, that must be applied to the material to determine an accurate unit cost, are figures that the cost man is pre-

eminently fitted to ascertain; and, second, because by means of his quantity survey the cost man can keep a very close check of the quantities of these materials used and on hand.

Finally, materials like brick, sand and lime that are directly chargeable to a construction account, and therefore not carried in stock, are kept separate in a suspense account under the construction account. As this material is actually used, it is transferred from the suspense to the structural account. Form lumber is journal-entried from stock at full cost into such a suspense account, under forms, as new lumber is made into forms. From the suspense account, lumber is transferred direct to forms account at cost divided by the estimated number of times that the forms will be used, the quantity of lumber being determined from the forms erected, regardless of whether the lumber is new or re-used. For example, if we assume that the forms will be used three times and the assumption is correct, the suspense account, at the end of the job, will be credited with three times the quantity of lumber with which it has been charged, since every foot of lumber that was charged to suspense, as it entered into the fabrication of a form, was credited three times to the suspense account, as it appeared in forms erected. But inasmuch as the lumber was credited to suspense at only one-third the cost, suspense will obviously be closed out as far as money is concerned. If at the end of the job the assumption proved to have been wrong, and generally some time before the completion of the work a fairly close estimate can be made of the number of times the lumber will be used, an adjustment necessary to close out suspense is made for the lumber charged out.

All the above methods of dealing with material charges are to enable the firm to obtain at the end of every month during the life of the job an accurate indication of what the costs of the completed work are going to be. Any tendency for material costs to become excessive can be countered in time.

Quantities—All the care spent in properly allocating cost to the various items of work would be *practically wasted if a system of accurately obtaining units of work done were not maintained.* A schedule of quantities is made out in advance so that the quantity man can definitely assign to any period the work done during that period, without having to determine the work done to date and take therefrom the work previously reported. The buildings are divided into convenient units, preferably those detailed and key-marked on the drawings. Thus, for the concrete, one story is taken at a time, and the beams, slabs and columns are listed according to the key given on the drawings, the class or type symbol being also shown for reference to the detail drawing giving dimensions. The quantities of concrete in each of these units is then computed and recorded in a column provided for estimated quantities. As the construction proceeds, the quantity man has merely to note on his rounds in the field the location of the work during any period, taking a check measurement here and there to discover any changes in plan that might not previously have come to his notice.

Upon his return to the office he places the date or dates against the units done, and if the unit in any case is entirely completed as planned, the correct quantity is shown in the "actual" column. The quantity for the period will then evidently be the sum of all the units or partial units completed, as marked against that period.

The refinement with which these quantity units are scheduled must, of course, be left to the exigencies of the case. Obviously where the quantities are to be taken only weekly, a large unit, such as an entire slab, or one story of the wall, might be taken; on the other hand, where units are desired every day, and bills of material accompany the plans for each detailed member, beams, columns and panels may to great advantage be selected as the units.

With this system it was found possible for one man to report reliable daily quantities of concrete, forms and reinforcement for a group of ten buildings being erected simultaneously, and in all stages of progress. As a rule 1½ hours was sufficient to locate the work done during the day and 4 hours to post the units done and summarize them on the daily report. The remainder of the time was spent in scheduling the future work.

Quantities to date should be independently reported at the end of the month, and checked against the accumulated totals.

Costs—All payments are made by check, so that the total expenditures at the end of the month are easily checked against the bank balance by means of the record kept on the check stubs. Ordinarily, every purchase is recorded by a triplicate invoice to which a voucher in triplicate is attached, covering the payment and its distribution. Services are similarly recorded by attaching vouchers to the bills.

For miscellaneous small cash payments, a petty cash fund is maintained. This fund is reimbursed from time to time for these small cash items, by a check drawn in favor of the cashier. A voucher is made to which are attached the receipts for all of the items for which the fund is reimbursed. For the payroll, a check is drawn in favor of the paymaster, who pays the laborers with the cash so secured. The payroll signed by the payees, is then attached to the original voucher covering the payroll disbursement. On some jobs the men are paid by check instead of cash. In such cases the payroll voucher is backed by the cancelled wage checks instead of the receipted payroll.

Having accounted for all expenditures by vouchers, the accountant posts the vouchers, classifying them according to the controlling accounts listed under the "Index" of the Classification. At the end of the month, a trial balance is struck from these sheets and given to the cost man. The latter then determines what further entries are desirable, such as, for instance, transferring from stock material used during the month, and apprises the accounting department of these. Such entries made, the sheets are finally closed, balanced with the bank balance, due allowances being made, of course, for checks in suspense and a final balance sheet drawn off and given to the cost man.

In the meanwhile, as the vouchers are issued and entered by the accounting department, the cost man enters them in his cost ledger, recording such detail as is considered necessary to secure a complete cost record. Thus for every material voucher, the voucher number, order number, description of the material, quantity and cost are entered; for payrolls, the voucher number, date of payroll, description of charge and the amount are posted; for journal entries, the voucher number, the journal number, details for reference, and the amount are indicated. The purpose in view is to leave nothing to memory or supposition; every item posted is referenced and described sufficiently to enable its being checked five years later if necessary.

When all the vouchers for the month have been entered, the cost man totals the sub-accounts under every controlling account, and checks the controlling accounts with the accountant's books. He has then an accurate detail of expenditures which he knows are definitely accounted for, and which he uses as the basis of the monthly cost statement described in the next section.

Reports—Coming now to the combination of the data obtained from the processes detailed above, one is confronted with a problem that cannot be definitely solved unless it is known what use is to be made of the results. A detailed report of unit costs, eagerly and also profitably absorbed by the job superintendent, might prove a pitfall for an executive interested only in the financial status of the job. Again a statement intelligently satisfying the client as to the proper disposition of the funds he is called upon to furnish may leave the superintendent in ignorance as to the quality of his work.

Two sets of reports can well be used to meet these requirements and yet eliminate overlapping of work; first, a daily or weekly report on the unit cost of labor; second, a monthly cost statement. The first is designed to give the superintendent a daily or weekly unit labor cost of the principal items of construction so that he may know as quickly as possible after the work is done what the labor cost is. Such detailed reports are, of course, of value only to those immediately in touch with the actual work.

The monthly cost statement is a detailed report that seeks to meet the demands of all of the individuals concerned in the progress of the work. Formerly this report was issued as at least three separate statements, but the combination of these has been found materially to lessen the work of compilation, and at the same time gain a breadth of perspective not attaching to the separate reports. It is composed of a summary sheet giving first the expenditures against all the controlling accounts; second, outstanding orders chargeable to the accounts; and third, any additional indebtedness to which the contractor is committed. The total of these three for any account gives the total amount

of money to which the contractor has committed himself in connection with the work represented by the account. The sheet, further, shows the official estimate for all controlling accounts and the changes authorized. Should indications have warranted a revision of this estimate, the revisions are included in the figures given in the column provided for the latest revised estimate. The total amount of money committed, plus what money is deemed necessary to finish, equals this latest revised estimate. The previous revised estimate is also given for comparison. This portion of the report used to be covered by a separate report called the Monthly Revised Estimate.

The summary sheet is followed by detailed, and as far as these are determinable, complete unit costs of all the work involved. All commitments are considered, and the quantities given are those that correspond to the cost indicated. Thus for limestone, for instance, if the material has all been ordered, the unit shown against first cost is for the entire estimated quantity. On the other hand, the quantity shown against "unloading" is the quantity received on the job; the quantity against "setting" only the quantity actually in place. The total unit cost is then obtained by adding the unit costs determined for each of the items given. This part of the statement satisfies the individuals interested in the disposition of the funds supplied, and also those concerned with the detailed financial status of the work. At the same time, the detail given is of value to those immediately connected with actual construction, as, for instance, the superintendent.

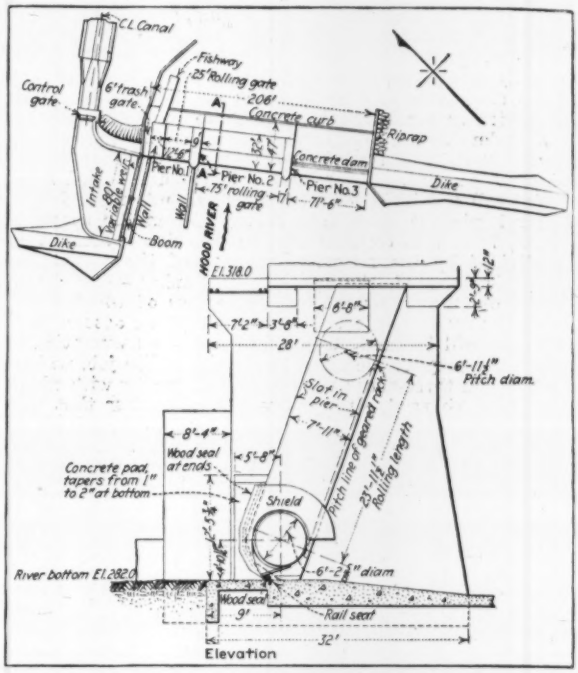
Graphs of various kinds have been designed and used to a varying extent to aid the superintendent in his conclusions regarding the status of the work, but none of these have been standardized for cost recording purposes. *It has been found that with simple progress curves examined in connection with the weekly and monthly costs the superintendent is able to form a very good opinion as to how his work is proceeding.*

Roller Gates Make Up the Major Portion of Powerdale Dam

Wide Range of Flow of Hood River and Narrow Valley Make Them Necessary — One 25-Ft. and One 75-Ft. Gate

By J. E. Yates
Assistant Chief Engineer, Pacific Power & Light Co., Portland, Ore.

THE RIVERS of the Pacific Coast which rise in the Cascade Range are very treacherous and difficult to control for power purposes. Their descent down the mountains is rapid and their flow ranges from great quantities in the months from November to June to a small amount in the summer months. Hood River, rising in the glaciers on the north slope of Mt. Hood and flowing in a general northerly direction to the Columbia River, is such a stream. Its flow varies from 300 to 30,000 sec.-ft. and the entire profile of the stream, from the glaciers in which it rises to its mouth, is so steep that not only do enormous quantities of silt and sand move downstream with every flood but the high velocity moves gravel, cobbles, and even boulders of three and four cubic feet in size. Any dam placed across such a stream creates a small reservoir which fills up during the first flood occurring. The profile of the bed of the stream above the dam then starts to build up to a line approximately parallel to the original stream bed and the height of the dam above it. This makes it impossible to turn a stream of clear water into the diversion works and very often gravel bars form in front of the intakes, so as to stop the diversion of water entirely. To correct these difficulties, some means must be provided for keeping the channel in its original location and for removing periodically the material deposited back of the dam.

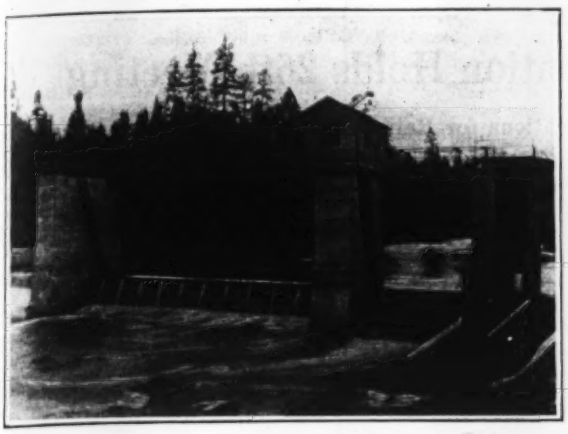


PLAN OF POWERDALE DIVERSION WORKS AND SECTION THROUGH 75-FT. GATE

Rolling crest gates with the sills practically at the stream bed level were adopted at the Powerdale plant of the Pacific Power & Light Co. because the possible length would avoid a jam of trees and logs between the piers, and because when raised during a flood the dam is practically removed and the large amount of excess water passing through the pond at a high velocity quickly sweeps the accumulated deposits clear and restores the channel to its original depth and location. When only small amounts of excess water are available, large quantities of sand and gravel can be removed from the pond by raising either of the gates a small amount. Provision is made for passing limited amounts of excess water over the top of the gates in order to reduce the amount of attention necessary. The gates can be raised well above the high water level reached during extreme floods.

The Powerdale development consists of the dam and intake works, 15,986 ft. of flow line canal, and a power house located near the junction of the Hood with the Columbia River in Hood County, Ore. It has a capacity of 7,500 kva. and utilizes 180 ft. of head.

The diversion works, 206 ft. in length, consist of a low concrete dam 71.5 ft. long, two steel roller gates, a fish ladder, a trash gate, and, at both ends, earth and rock dikes. A concrete mat forms the base for the dam on which rest three concrete piers supporting the roller gates. These gates are cylindrical in shape; one is 25 ft. long by 7 ft. 8 in. in diameter, operated by a 5-hp. motor, and the other 75 ft. long and 6 ft. 3 in. in diameter, operated by a 10-hp. motor. The gates are raised by means of a link chain and a sprocket wheel on one end of each gate. They roll as they are raised or lowered on a geared rack, attached to the piers, in which sprockets on the gates mesh. Guide irons keep the gates in position. Suitable stops prevent the gate from operating too far either way. A small building on the center pier houses the gate hoisting



DIVERSION WORKS, POWERDALE HYDRO-ELECTRIC DEVELOPMENT

Overflow weir at extreme left; Roller gates, center; fish ladder and trash gate, right.

apparatus. When the gates are in the extreme low position surplus water escapes over the top. In the upper position a clearance of about 26 ft. above the dam is secured which allows flood water to escape. A 6-ft. steel trash gate on the intake side provides an escape for débris or logs which are prevented from entering the canal by a boom.

The concrete mat upon which the lower edge of the 25-ft. gates rests when in closed position is 2 ft. 3 in. lower than the corresponding mat for the 75-ft. gate. This gives better control of the water and permits keeping the river bed at the intake free from sediment.

The remainder of the development is constructed along the same substantial lines as the intake. The continuity of service to be expected from a generating plant determines largely the expenditure justified for permanency. A plant which is to be used only a portion of the time will not warrant the investment which a plant to be operated on a high yearly load factor will. This development was expected to generate energy continuously throughout the year, consequently the intake as well as other parts of the development were made very substantial.

English Practice in Trade Refuse Removal

Of 56 English boroughs reporting on the subject of charges for removal of trade refuse, 31 reported making a charge, 19 made no charge, and 6 do not collect trade refuse. In several cases, states the London *Surveyor* of Feb. 20 in a reprint of a report on the subject made by J. Leigh Turner, town clerk of Blyth, the charge is made only where the amount of refuse exceeds a certain quantity defined by the local authority, usually one "bin." Borough engineers have charge of the collection in 26 of 51 boroughs reporting on this subject, and one borough reported that although the work was in charge of the sanitary inspector, the borough engineer supplied equipment and men; 15 reported the work in charge of the sanitary inspector (including one "sanitary foreman"), 2 others said that the work was conducted jointly by the sanitary inspector and the superintendent of the refuse department in one case and of the cleansing department in another; in 5 boroughs, the cleansing superintendent was in charge; and in *one only* was the work in charge of the health department.

Michigan Lower Court Enjoins Use of Lansing Garbage Piggery

AN injunction against the operation by the city of Lansing, Mich., of a garbage disposal hog farm in a high-grade farming community was granted on Feb. 16 by the Circuit Court of Eaton County in which the farm is located. The single judge in the case held that adjacent property owners had been damaged through lessened enjoyment of their homes and decrease in the value of their property. The case is subject to appeal to the State Supreme Court. We are indebted to Edward D. Rich, director, Bureau of Engineering, Michigan Department of Health, for the information on which the following notes are based:

For several years the garbage of Lansing was fed to hogs on a small tract within the city limits and adjacent to Grand River. To obviate difficulties due to the restricted area, the city, in 1921, bought 120 acres of land outside the city limits and in another county. There were three farm houses directly across the road from the property. The city located the hog ranch on 8 acres of land near the center of the property, provided feeding houses with concrete floors and sleeping quarters for the hogs in separate buildings. The hogs were allowed to run over the rest of the 8 acres during the day, but this area, the soil of which is of clay loam, was scraped once a week with a road machine and the scrapings disposed of.

After the garbage from the city is dumped on the feeding floors the hogs are admitted and subsequently the residue is heavily limed, removed and spread over the land by means of manure spreaders. The cans in which the garbage is brought from the city are washed inside a building provided with sewer connection. Two concrete pools, which also have sewer connections, are provided to obviate the necessity of hog wallows, but the feeding floors have no such connections. Mr. Rich states that he has visited the piggery a number of times and was surprised to see how completely the lime treatment had prevented odors from the garbage distributed over the land. Before the garbage was distributed by manure spreaders it was dumped on the land in piles and subsequently spread for plowing in, giving rise to objectionable odors, Mr. Rich states.

As soon as it was known that the city intended to take up with the new location for its piggery, the farmers objected and tried to obtain an injunction, but this was denied by the courts on the ground that no nuisance had yet been created. After the new plant had been put in operation a second suit, alleging nuisance, was brought by the adjacent farmers who introduced 68 witnesses. Some of these stated that windows had to be closed at night on account of the odor; that nausea was produced; that farmers had to discontinue work in certain fields at times; that social calls in the neighborhood were curtailed on account of the odors which it was alleged extended for a distance of more than a mile; and that there was an increase of flies in the district, particularly of blow-flies. Mr. Rich expresses the opinion that, although some of the witnesses made out that trifling annoyances were an intolerable nuisance, and although taking the garbage into a township in another county was a factor in the suit, yet on the whole the city of Lansing made a mistake in locating its new piggery so near to houses in a high-grade farming section.

Railway Engineering Association Holds 26th Meeting

Good Reports on Economic Subjects—New Specifications for Rails Adopted—Controversy Over Highway Crossings—Study of Passenger and Freight Station Design

THAT economic aspects of railway engineering in relation to construction, maintenance and operation are being given increasing attention in the committee work of the American Railway Engineering Association was evidenced by many of the reports presented at the annual meeting held in Chicago March 10 to 12. A different but very important line of activity was indicated in the second report of the new committee on Co-operative Relations with Universities; this committee sees a large opportunity, but it was made clear that unless the railways take steps to make the service attractive to the engineering students they cannot expect to realize the advantages attendant upon the employment of technically trained men. New specifications for steel rails were adopted. The comprehensive report on automatic train-control is of special interest and value at this time, and the president's address pointed out that railway engineers and officers in general must in future give more attention to developments in signaling and train-control as affecting their own particular work. Much of the material presented in the innumerable committee and sub-committee reports was in the character of information and called for no action, but there was a fair amount of rather scattering discussion.

Railway Economics—One group of reports was notable for the discussion of important economic subjects relative to railway construction and operation. Thus, the committee on Economics of Railway Operation discussed: (1) Relation of train speed to cost of operation, (2) the introduction of heavier steam locomotives to increase traffic capacity, (3) the cost of stopping and starting trains, and (4) allowances for maintenance-of-way expenses due to increased use or traffic. Of a similar character was the report of the committee on Economics of Railway Location in regard to estimating the relations of speed, time and fuel consumption. In this study the committee on Electricity has co-operated and E. B. Katte (New York Central R.R.), for the latter committee, pointed out that there are limits to the influence of the electric locomotive on railway location, since under certain operating conditions there would be no economy in introducing electric traction. An elaborate report on standard methods for performing maintenance work, presented by the committee on Economics of Railway Labor, included the establishment of units of measure for such work and the programing or scheduling of maintenance-of-way operations with a view to securing the most economical applications of labor. Along similar lines was the report of the committee on Records and Accounts, which dealt with cost-keeping methods and statistical records for controlling expenditures; it also discussed improved time-books for records of maintenance work and suggested methods of keeping valuation records up-to-date. It was notable that little or nothing was said at the convention in regard to standards or standardization.

Rails and Track—A notable action of the convention was in adopting with little discussion new specifications for open-hearth rails, submitted by the committee on Rail and omitting "non-essential features which have entailed dissension between rail manufacturers and railways," to quote the report. Of course it is a matter of opinion as to how far the omitted features were "non-essential," but apparently these specifications meet the approval of the mills. The report stated that practically all rail contracts in recent years have been based on the Association's old specifications of 1915, the present standard specifications of 1920 not being used, "largely because of price penalties imposed by the rail makers."

As to transverse fissures, the report states that there seems to be the same predisposition of certain furnace heats towards failures of this type, but that there has been a material reduction in such failures during recent years under traffic conditions more severe than those which produced larger numbers of failures in the rails of earlier years. Tests are being made to determine the relation of deformation under stress to the formation of transverse fissures. Rail failure statistics indicate a gradual improvement from the peak record of 1917. Heavy rails show greatly increased life in relation to their weight.

As to rail length, the committee's new specifications provide for a standard length of 39 ft., and many contracts for such rails have been made without a price penalty. The committee prefers 45 ft. and suggests that facilities for such production may be made in remodeling rail mills. As to rail sections, J. L. Campbell (Southern Pacific Ry.) suggested the advisability of giving a uniform width of head and base for several weights of rails, in order to simplify the tieplate problem. This can be done, in his opinion, without affecting other requirements as to strength and form of section.

Canting rails inward about 1 in 20 by means of inclined tieplates is recommended by the committee on Rail in conjunction with the committee on Track; this practice is endorsed also by the extended investigations of the committee on Stresses in Track, which had a lengthy report upon this subject. Rerolling old rails is not economical at present prices, according to the committee on Track, but is likely to increase with the increasing use of rails of more than 100 lb. per yard. Resawing is held to be good practice, preferably by portable plants to save cost of transportation, while the oxyacetylene process is the most economical method of reconditioning rails in the track. From the discussion it appeared that the Delaware, Lackawanna & Western R.R. and the Rock Island Lines have had good results from rerolled rails, while experience on the Missouri Pacific has been unsatisfactory. All three methods are being used by the Rock Island Lines, but it was noted that if reconditioning by welding is to be economical it must be done before the rails are too badly worn. New rules for expansion spacing of long rails were submitted. For track in paved streets the committee recommends 7- and 9-in. rails with tierods or brace plates and 18 ties per 33-ft. rail length; stone block on concrete is deemed best for heavy vehicular traffic.

A tentative design for a steel tie composed of a commercial channel section was submitted by the committee on Ties. It also presented a long review of foreign woods, but stated that there is no hope of finding woods that are both strong and durable to meet a shortage of American ties. Steady reduction in tie renewals due to the increasing life resulting from the use of treated ties was noted by J. L. Campbell (Southern Pacific Ry.) who urged a comprehensive study of the economic advantages of treated ties. Several speakers referred to a definite economy resulting from the use of treated red oak (otherwise an inferior timber) as compared with untreated white oak, while some roads, including the Baltimore & Ohio, are treating even white oak. In regard to treating wood with creosote-petroleum and zinc-petroleum mixtures, the committee on Wood Preservation stated that petroleum retards or prevents checking and splitting, but the mixture must contain sufficient zinc or creosote to prevent decay. Specifications for tie plugs were amended to provide that all plugs should be of treated wood.

Ballasting by contract has been regarded unfavorably by the association in the past, but in view of the adoption of this method by some railroads the committee on Ballast prepared typical specifications and contract for such work. These were adopted, as were the committee's revised specifications for stone ballast, giving a range of ¾ to 2½ in. in size. Track having stone or coarse gravel ballast gives little trouble from dust, according to the committee on Roadway, which suggested that oiling is desirable at road crossings, in sandy and desert regions, and at stations and freight yards.

Highway Crossings—The importance of the problems of protection and elimination of railway and highway grade crossings was illustrated by the fact that it was noted in the presidential address and in at least two committee reports. In regard to the elimination of crossings, as discussed by the committee on Signs, Fences and Crossings, R. H. Ford (Rock Island Lines) objected to the tone of the report as placing too much responsibility on the railways and advocating the costly remedy of elimination. An average cost for such work is $75,000 per crossing; but adequate protection by signals and safeguards can be provided for $1,300 and the public should not be given to understand that the railroads may be expected to do more than provide effective warning or protection. This view was opposed by George J. Ray (D., L. & W. R.R.) who favored ample co-operation with public authorities and who, in his presidential address, suggested that the association should undertake some method of effecting such co-operation.

Economic aspects of the problem were discussed by the committee on Signaling and Interlocking, which recommended flashing or wig-wag signals at crossings and suggested the adoption of a standard crossing sign to which these signals can be attached, as the association's present standard design is not suitable for the purpose. Amended specifications for bituminous paving of road crossings were submitted by the committee on signs, Fences and Crossings, which also presented a digest of state laws apportioning the cost of street and highway improvements adjacent to railway right-of-way. The oiling of crossings to prevent dust was advocated by the committee on Roadway.

Bridges and Structures—In order to make clear what are "power-driven" rivets, the committee on Iron and Steel Structures submitted the following note for the specifications on railway bridges: "Rivets driven and bucked by pneumatic or electrically operated hammers are considered power-driven rivets." This was adopted. Instructions for the maintenance inspection of steel bridges, with standard form of report, were submitted as information, for the purpose of having them considered preparatory to being recommended for the "Manual." The subcommittee on steel highway bridges will require another year to complete its work. In presenting conclusions as to open-deck and ballast-deck trestles, the committee on Wooden Bridges and Trestles stated that the relative economy cannot be demonstrated mathematically, but may be determined by a comparison of annual investment cost with annual maintenance cost, bearing in mind also the many advantages of a ballasted deck which are not susceptible to monetary equation.

This committee recommended the adopted of the American lumber standards as developed by the lumber industry and approved by the U. S. Department of Commerce, but there was strong objection to such action because no grading rules based on these recommendations had been prepared which could be substituted for the material now in the "Manual." Hermann Von Schrenk (New York Central) pointed out that no important company was supplying lumber on the new basis although most of them have accepted the new recommendations. On motion of Mr. Von Schrenk this part of the report was simply accepted as information. A final report on the useful strength of new, old and treated timber pointed out that this must be largely a matter of judgment based on previous knowledge.

The question of the inflammability of timber trestles was discussed at the time the committee on Wood Preservation presented its report. A subcommittee reported upon a number of tests in which treated and untreated timber had been subjected to fire and in which the treated timber while appearing to burn briskly at the start was in reality only giving off gases which burned, and that when the fire went out the treated timber was found to be sound and only charred on the surface while the untreated timber was badly burned. Hunter McDonald called attention to a fire in a trestle of treated timber on the Nashville, Chattanooga & St. Louis Ry., in which the fire burned briskly for two and one half hours and was so hot that nearby trees were killed, yet when the fire was out it was found that no serious damage had been done to the trestle and that traffic could be resumed at once. A similar fire in another trestle resulted in the destruction of some untreated piles in part of the supporting bents but little damage was done to the treated timber except in the case of some of the lighter members in the bracing.

The committee on Wooden Bridges and Trestles recommended that the manual of the association be published in loose leaf form so that revisions could be inserted.

A report on the economic aspect of filling bridge openings, presented by the committee on Roadway, was practically the same as its report of 1924, which had been referred back for further consideration, the committee stating that it had found no arguments justify-

ing a change. However; some features of the report came in for sharp criticism and it was again referred back to the committee. In a report on the principles of design of concrete structures, the committee on Masonry dealt with culverts subjected to embankment loads, submitting recommendations for live- and dead-load and a new formula for impact load. These were accepted as information. In load tests on metal culverts, to be undertaken in co-operation with the committee on Roadway on a new line of the Illinois Central R.R., Goldbeck cells will be left in the bank and the pressures observed over a number of years.

The Masonry committee presented a report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. Rules for the inspection of masonry structures were also submitted. In the discussion on concrete, C. C. Westfall (Illinois Central R.R.) objected to recent criticisms of railway engineers (presumably those in *Engineering News-Record*) as being backward in the use of methods for securing good concrete. Recommendations of the committee on Buildings that its previous specifications for clay and concrete tile, artificial stone, heating plants and electric wiring should be adopted for the "Manual" were adopted, as were its revised conclusions as to floors for enginehouses and freighthouses, which had been referred back at the 1924 meeting. Specifications for prepared roofing and plans for station signs were submitted as information.

Yards, Stations and Shops—An extended discussion of passenger and freight terminals, submitted by the committee on Yards and Terminals, was the continuation of a comprehensive study of matters involved in station and terminal design. It included the operation of one-level and two-level freight stations, the facilities for large passenger stations, and the design of freight yards in order to facilitate train movements and thus reduce train delays and overtime wages. In the discussion it was questioned whether the mathematical analysis of certain features could be applied in practice, but it was shown that these methods have been developed in dealing with specific problems of design. The committee's extended study of scales has been continued and its recommendations were adopted in regard to tolerances for heavy-duty automatic indicating scales. Its report called attention to motor-truck loads as high as 25 tons, which are far beyond the loads contemplated in previous specifications for motor-truck scales, so that investigation must be made as to possible revision of these specifications.

Freight-car repair shop design was reported on by the committee on Shops and Locomotive Terminals. In regard to the ventilation of enginehouses, it recommended a complete monitor or at least one break in the roof surface, this break to be fitted with pivoted sash or a combination of pivoted sash and fixed louvres. Layouts of oil stations for the storage and distribution of fuel oil were also submitted; supplementary to this subject was a report of the committee on Electricity as to the protection of oil sidings from the dangers incident to stray currents liable to cause sparks.

Miscellaneous—That the hydraulic ram is serviceable and economical for railway water supply, where conditions permit its use, was a conclusion of the committee on Water Service; this committee finds that fuel oil is the cheapest power for pumping water; electricity with automatic control ranks next, but may rank first if it enables the number of pumpers to be decreased. As to materials for closing joints in cast-iron pipe, there is increasing use of a composition of iron, sulphur, slag and salt, but lead is most extensively used. A statement of the Minnesota State Board of Health on the protection of wells for the water supply of small stations, section houses and camp trains was appended to the committee's report, and in the discussion further co-operation between the association and the U. S. Public Health Service was advocated. In regard to the influence of water supply on locomotive repairs, C. H. Koyl (C., M. & St. P. Ry.) stated that in bad-water districts the treating of the water may result in a saving of $1,600 to $4,000 per locomotive per year, depending upon the quality of the raw water. If the improvement in operating conditions is taken into account, this saving may reach $8,000.

A review of the purpose, history and development of automatic train-control systems, submitted by the committee on Signals and Interlocking, was commended as being specially useful for the information of railway engineers in general. Last year the committee came in for criticism for failure to make a report on this subject. A complete set of rules for maintenance employees, floating gangs, and bridge and building gangs, submitted by the committee on Rules and Organization, included special rules for working in electrified territory. There was some objection to the length and detail of these rules. Tentative rules were presented for first-aid relief and for the handling of explosives. Beyond recommending specifications for the construction of overhead electric supply lines for railway work, the various subjects covered by the committee on Electricitiy were dealt with in progress reports.

Agreements presented by the committee on Uniform General Contract Forms included the joint use of passenger stations and of poles on right-of-way, furnishing water and purchasing electric energy. As to the last, some modifications were suggested by D. J. Brumley (Illinois Central R.R.). This committee has also cooperated with the committee on Roadway in preparing a revised form of grading contract.

Railways and Engineering Colleges—An interesting report of the committee on Co-operation with Universities was presented by R. H. Ford (Rock Island Lines). This committee hopes to reach, interest and inform the students best fitted for railway service; its report notes evidence of increasing co-operation between industries and the colleges, the former to find what may be expected of the colleges and the latter to ascertain the requirements of industries. Dean Ketchum, of the engineering college, University of Illinois, stated that certain industries which make a specialty of interviewing and inviting students find that technically trained men will reach a position of responsibility in six to ten years less time than men without such training. The railroads would have the same experience if they followed a similar policy, but unless they are prepared to assure the technically trained men of opportunities to advance it is no use trying to get them into railway service. The students soon learn where opportunities lie and will go in that direction. The colleges can supply the students and there is a field for them in railway service, but it is up to the railroads to make this field attractive.

Developments in Railway Engineering and Economics

Extracts from Numerous Committee Reports, Covering Design, Practice and Economics in Railway Construction and Maintenance, at the Convention of the American Railway Engineering Association

Freight Yard Design

Committee on Yards and Terminals

IN THE design of a new yard, or in planning its operation, and in the study of an existing yard with a view to reducing delays the point to be constantly borne in mind is that where the total cost of operating, maintenance and fixed charges on the additional or improved facilities can be shown to be less than the cost of the terminal time and delay which they will eliminate, the expenditure for these facilities, all other things being equal, is justified.

The length of the tracks in the receiving or departure yard should be such that each track will accommodate a complete train. The connection between the receiving or departure yard and the main track should be as direct and as simple in alignment as practicable. There should be a pulling-in or pulling-out track, or both, somewhat longer than a maximum train length; or an inbound or outbound freight running track, or both, extending to or beyond the first telegraph office outside of the terminal yard and operated as a freight main track.

Compressed air at suitable pressure should be piped into both the receiving yard and the departure yard, so that the air brake equipment may be tested by the yard forces as soon as the cars of a train are received or assembled. It may be economical to have switches to be run over by the locomotive in moving to and from the mechanical plant and by the train in moving to and from the main track handled by switch tenders or interlocking plants.

The distance from the head end of the receiving yard to the mechanical plant should be as short as practicable and the arrangement of tracks for this movement of the locomotive should be such as to require it to pass over a minimum number of switches and meet as little conflict with other trains and engines as possible. A special engine running-track for this movement, which will be kept clear of all other movements, is usually desirable and frequently essential if loss of time is to be avoided. Conflict with arriving and departing trains, and with work going on in the yard may cause serious loss of time to a locomotive moving from the receiving track to the mechanical plant if such conflicts are not foreseen and provided against in the design and operation of the yard.

* * *

Loads on Culverts in Fills

Committee on Masonry

FOR the determination of vertical loads to govern the design of railway structures subjected to embankment loads:

1. The dead-load should be assumed as the weight of the track, ballast, fill and culvert masonry embraced within the vertical prism above the portion of the structure under investigation.

2. The live-load on structures buried to a depth of 3 ft. or more below base of rail shall be assumed as distributed uniformly in a longitudinal direction. Except as modified in paragraph 3, it is further assumed to spread transversely so as to give a uniform distribution of pressure on all horizontal planes lying between two planes inclined at outward slopes of ¼ to 1, these planes being fixed by lines drawn through the ends of the ties at the base of rail.

3. The spread of the live-load shall be assumed at not less than 13 ft. unless slabs under relatively limited depths of fill are divided by longitudinal joints into units of such width that some possible location of the track or tracks will result in a concentration of the live-load on the slab or slabs, that would necessarily exceed that indicated by the above assumption. Such cases must be analyzed individually.

4. The live-load for a depth of fill of less than 3 ft. below the base of rail shall be assumed as concentrated wheel loads.

5. The impact load shall be derived from the accompanying formula. No specific value for K is recommended but it is suggested that a value of 1.0 represents conservative practice.

$$I = K\left[\frac{L}{L+D}\right]L$$

where I = the impact load
D = the dead-load as derived according to paragraph 1
L = the live-load as derived according to paragraphs 2, 3 and 4.
K = a coefficient.

* * *

Open-Deck and Ballast-Deck Trestles

Committee on Wooden Bridges and Trestles

THE open deck trestle has the advantage of lower original cost, greater adaptability in temporary or emergency installations, and lower costs in effecting renewals under traffic. The principal advantages of the ballast deck trestle when compared with the open deck type are: (1) Better protection against loss and damage and interruption in train service due to fire; (2) superior track riding qualities; (3) more satisfactory and safer appearance; (4) greater serviceability and better performance when subjected to overload; (5) vastly less expensive to maintain. If the difference between the annual investment cost of the two types equals or only slightly exceeds the annual cost of maintenance of the open-deck type, the ballast-deck type will be the more economical.

* * *

Road Crossing Signals

Committee on Signals and Interlocking

AN ELECTRICALLY or mechanically operated signal shall present toward the highway, when indicating the approach of a train, the appearance of a horizontally swinging red light and (or) disk. The railroad standard highway crossing sign and the signal shall be mounted on the same post. Automatic signal devices shall indicate the approach of trains for not less than 20 seconds before the arrival of the fastest train operated over the crossing. For flashing signals, the lamps shall be 6 to 9 ft. above the highway and 30 in. c. to c. horizontally; the lights to flash alternately with 30 to 45 flashes per minute for each light. For wig-wag signals, the length of stroke, measured as a chord between extreme positions, shall be 30 in. and the number of cycles or double strokes shall be from 30 to 45 per minute.

* * *

Fuel-Oil Storage Tanks

Committee on Shops and Locomotive Terminals

CYLINDRICAL steel tanks of 55,000 and 80,000 bbl. capacity, on leveled earth foundations, provide convenient and economical storage. Roofs should be of steel or wood frame and sheathing, covered with asbestos, composition, tar and gravel, or sheet metal. In permanent installations, or for oil having large gasoline content, floating roofs and gastight steel roofs equipped with breather pipes have the advantage of reducing evaporation of gases and danger of fire. Each tank should be surrounded by an earth dike, enclosing a volume equal to 1½ times the capacity of the tank.

Means for the escape of gases will depend on the tightness of the roof and the character of the oil, but should be designed to reduce circulation of air over the surface of the oil to minimum consistent with prevention of pressure due to the accumulation of gases.

The larger oil companies tend increasingly toward the use of all-steel vaportight roofs on permanent installations of large storage tanks. The loss through evaporation of valuable elements from the oil, as well as the danger of fire from lightning or from fires in the vicinity, is reduced

materially by this practice, especially where the oil contains considerable quantities of the more volatile constituents. The residuum in general use as fuel oil, from which the lighter elements have been extracted by refining, is less subject to loss through evaporation, as well as less readily inflammable. While some railroads which have experienced serious loss by fire are now using vaportight roofs, many are still using the wood sheathed roofs and feel that they are not justified in incurring additional expense for steel roofs.

Floating roofs, to eliminate loss by evaporation and danger of fire, are being tried experimentally. They are more expensive than the steel roofs, and of value chiefly for the storage of the more volatile and inflammable oils. Some oil companies report successful use of concrete tanks for large storage, practically all the oil-using railroads recommend steel tanks for such storage, though several use concrete for small service and sump tanks, especially where such tanks are underground.

* * *

Canting Track Rails

Committee on Track

OF 67 railroads, 33 are canting rails as standard and 14 as experimental practice; 30 use an inclination of 1 on 20; 17 use approximately 1 on 40 and three use approximately 1 on 80. Canting is accomplished by the use of inclined tieplates, though a few roads adze the ties. No special provisions through switches are necessary, except to bring the rails gradually to a vertical position by adzing the ties. Advantages of canting indicated in the replies include the following: Maintains gage; more uniform wear of rail head; central loading of rail head; full bearing of wheel on rail head; increases life of rail; prevents tie cutting; increases life of ties; more economical design of tieplates; reduces flange wear on curves; causes less wear on wheels; may tend to reduce transverse fissures. This committee endorses the conclusions of the committee on Stresses in Track: (a) Canting the rail inward reduces the lateral bending stresses in the rail for both tangent and curved track and causes a more central contact of wheel on rail; (b) the most benefit is obtained from a cant of 1 on 20.

* * *

Sawing and Conditioning Old Rails

Committee on Track

THE conditioning of rails by re-sawing is practiced on 24 railroads which re-saw annually 200,000 tons at an average cost of $1.79 per ton, or $3.63 per ton including transportation. This practice is generally satisfactory and is on the increase. A few roads contract the work, but the expense is somewhat greater than that done at company mills. Where rail is to be relaid at its old location, portable sawing plants will eliminate transportation charges, the expense of sawing is not materially greater, and there will be a better joint fit than when rails are sawed at the mill and relaid indiscriminately.

There is no economy in re-rolling rail at present high costs, but with the renewal of rails of 100-lb. or larger section this practice will probably increase. As the quantity increases the price of re-rolling will be reduced. Reconditioning rails by building up battered ends in the track by oxyacetylene welding is rapidly increasing. The expense is controlled by the condition of the rail and would be less if the work was done before the dip in the rail at the joint became too great. It is generally more economical than re-sawing, because it eliminates the loss due to cutoffs, eliminates transportation charges and decreases the number of joints in the track. The work is also done without traffic interruption. If careful attention is given to the renewal of angle bars, the life of the rail is about as great as when it is re-sawed.

* * *

Dustless Railroad Track

Committee on Roadway

THE most common method for eliminating dust has been by spraying with crude oil, but the practice is by no means general and several railroads have discontinued it as being unsatisfactory. Several roads in the Middle West and Southwest use oil to some extent; two roads use water as well as oil and report fairly satisfactory results. The cost varies greatly. One road in the East uses 600 gal. of oil per mile and the total expense averages $35. One in the Middle West uses 2,000 gal. per mile at a cost of $85 and another uses 2,500 gal.

Some sand-ballasted railroads of the South have planted Bermuda grass which in a short time covers the surface of the road bed and eliminates dust. To prevent blow sand from covering tracks along the Columbia River it has been found advantageous to spray the ground for a distance of 300 or 400 yd. from the track to form an asphalt coating which holds the sand in place. This costs from $30 to $40 per acre.

Railroads which are stone-ballasted need have little trouble from dust, except at road crossings and station yards and these places can be oiled. With washed gravel or even with coarse gravel where speeds are moderate there is little trouble from dust. But where the ballast is light and sandy the dust becomes a great nuisance. Oiling the roadbed is advisable in sandy and desert regions where the rainfall is light, but the results are much less satisfactory in districts having a normal amount of rainfall. Station and freight yards and driveways can be oiled to advantage and the same is true of highways crossing or adjacent to railroad tracks.

* * *

Pumping for Railway Water Stations

Committee on Water Service

THE variety of the different methods for supplying water at present is illustrated by one railway system which has 145 steam pumping stations, 30 oil-engine stations, 14 gasoline stations, 20 electrical stations, 2 stations supplied by windmills, 3 stations where the roadside tank is filled by the pressure flow from artesian wells and 104 stations supplied by city water. The hydraulic ram makes a very serviceable and economical installation where local and individual conditions permit and should be given greater consideration where operating conditions are favorable.

Fuel oil is the cheapest power method for pumping water; electricity with automatic control is the next cheapest; steam and electricity with pumpers in attendance are the most expensive. The economy in the lower power cost of fuel oil may be offset in some instances by decreased cost of attendance where it is practicable to decrease the number of pumpers by installing automatically operated electric pumps. Where water station construction is contemplated and it is necessary to decide on the relative economy of city water, or the use of an oil, steam or electric pumping station, a comparative estimate should be made showing the annual cost of furnishing water per 1,000 gal. under each method, with allowance for all local conditions affecting the operation and maintenance of the station.

* * *

Treated Timber for Railroad Structures

Committee on Wooden Bridges and Trestles

TIMBER is treated with various preservatives to prevent decay and thereby loss of strength, but complete data of the effect upon the strength properties are not available. The emphasis of research in timber preservation has been upon the economical lengthening of life of the timber rather than the retention of the strength. Commercial treatment may decrease the strength as much as 50 per cent, but it is possible to give commercial treatments with so little injury that the same working stresses can be used with treated as with untreated timbers.

The weakening is primarily if not entirely due to the process and not to the preservative. Even though treatment may decrease the strength of the timber when new, yet it is possible for structures built of treated timber to have a greater reserve of strength than those of untreated timber, so that there comes a time when the treated timber structure will have more useful strength left in it than if it were untreated. The design of timber structures of treated material should be based upon reduced values of working stresses determined by judgment from knowledge of the specific timber and the process to be used in its treatment. The classification of old structures of treated timber must be done as a matter of examination for defects and judgment of the effective strength.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

A New Soil Mechanics

REVIEWED BY GEORGE PAASWELL
Structural Engineer, New York City

ERDBAUMECHANIK AUF BODENPHYSIKAELISCHER GRUNDLAGE—Von Dr. Ing. Karl Terzaghi, Zivilingenieur und Professor am Amerikanischen Robert College in Konstantinopel. Leipzig und Wien: Franz Deuticke. Paper; pp. 399; 7 x 10 in.; 65 line cuts.

Until very recent date the field of Earth Works has been considered the domain of the "practical" engineer and, aside from a half-hearted attempt to employ Rankine's classic expressions, mathematical treatment of soil problems was viewed as questionable and its results of no practical worth. It is with high satisfaction that the reviewer notes the decision of the author to wipe the slate clean, so far as the classic theories are concerned, and predicate an analysis upon the physical properties of soils as met with in nature. A vast amount of original research by the author supplies the basis for the study.

Through this investigation it is found that the behavior of soils is traceable to their grain make-up. Soils of the same effective size may differ widely in properties because their grain shapes are different. Structural changes in soils are due not only to minute deformations of the grains but also to grain rearrangement. Resisting such rearrangement are the frictional forces at the contact points of the individual grains and the hydrostatic stress systems induced by the pore waters, such as surface tension, capillary stresses and whatever unbalanced hydrostatic stresses exist due to the movement of these pore waters.

Land is found to be amenable to quasi-elastic methods of analysis, which is applied with exceedingly profitable results. We have got beyond the stage where the only answer to the question, What type is the soil? is, It will carry 4 tons per sq.ft. That brings very little information. How does the soil act under load? What are the characteristic settlement curves and how does time enter into the deformation changes? The development of the well-named "soil mechanics" is on a firm foundation and Dr. Terzaghi has been no mean contributor to its theorems.

Clay receives a remarkably keen and illuminating study. The water content supplies the film around each particle that, by surface tension and capillary stresses, effects cohesion. The scale-like formation of the clay particles brings into contact a much larger area than the spherical particles of sand, both grains having the same effective size. Thus the author explains cohesive action. Moisture content alone is not sufficient; there must be ample surface in contact. Substantially all physical properties of clay—plasticity, ductility, toughness—are functions of water content. Swelling and shrinkage in clay are in no way distinguishable from structural changes effected by pressure alone.

The continued settlement of a soil during a period of constant load and the decrease of pressure with time as a soil mass is kept constant in volume are ascribed to the gradual adjustment of the unbalanced frictional forces and the hydrostatic stress systems of the pore waters. A rapid sedimentation of fine particles, as silt, leads to unbalanced pore water stresses, the grain arrangement remaining unstable as the grains slowly acquire more stable formations. The failure of the core of hydraulic-fill dams is attributable to this phenomenon. Intimately connected with this study is the theory of percolation, its relation to erosion and to foundation failures. Practical application may be made of some of the detailed descriptions to the seepage lines in earth dams as well as to ground movements caused by such seepage.

Distribution of loads through soil, pile resistance, and the retaining-wall problem are discussed at much length. The classic theories of lateral earth pressure are discarded in toto, a matter of no great moment. Unfortunately the author confines most of the discussion to sand fill, not the most frequent kind. An interesting discussion of quicksand is also given.

The author devotes some pages to the discussion of excavation methods for the various soils types, rounding out in complete shape the general text of Earth Works. Among other topics of interest is the question of frictional forces.

The work takes rank as a pioneer textbook on the subject of earth works from a soil mechanics standpoint. Yet a large portion of the matter is speculative and opens up, rather than stills, controversy. An optimistic student of soil research problems will say that the author has placed upon a firm footing the fundamental theories of soil action and properties and has gone far to place soil mechanics among the exact branches of engineering design. A very conservative student will note the careful digest of experiments, the conscientious tabulation of soils according to a rational physical classification, giving a fairly unique identification, and an excellent method of designing foundations in accordance with soil settlement curves, and will content himself with the classic observation of an English scientist that it is far better to found a science on a theory later proven erroneous than to let chaos reign.

Geology for Engineers, Revised

ENGINEERING GEOLOGY—By H. Ries, Ph.D., Professor of Geology in Cornell University; and Thomas L. Watson, Ph.D., Professor of Geology in the University of Virginia, and State Geologist of Virginia. Third Edition, Revised. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 697; halftones, line drawings, plates, maps, index. $5.

Since figuratively and literally geology is the foundation of much engineering work, it is a pleasure to note that this commendable book has now reached a third edition. Earlier editions were favorably noticed in *Engineering News*, Sept. 17, 1914, and Jan. 20, 1916. The second edition was somewhat enlarged, chiefly by a new chapter on Historical Geology. In the present edition some chapters have been rewritten to bring them to date in accordance with suggestions from those who have used the book in classrooms. Practicing engineers might well add the volume to their library.

Authorized Biography of Steinmetz

CHARLES PROTEUS STEINMETZ: A Biography — By John Winthrop Hammond. New York: The Century Co. Cloth; 6 x 9 in.; pp. 489; 18 halftones. $4.

Few engineers have lent themselves so well as the late Dr. Steinmetz to an interesting and stimulating biography. Born in Poland, "hounded by Bismarck's police" for socialist activities at the University of Breslau, Steinmetz fled to Zurich on the eve of taking his university degree with honors. After dogged persistence he obtained entrance to the Zurich Polytechnic Institute, notwithstanding his inability to get a residence certificate from Breslau. An emergency causing his roommate to return suddenly to America, Steinmetz accepted the former's offer to pay his fare to New York. A letter of introduction from the editor of a German publication to which Steinmetz had been contributing electrical articles resulted in a position with Rudolf Eickemeyer, a manufacturer of Yonkers, a pioneer in the design of alternating current machines, who, with his partner, Field, later sold his electrical interests to the General Electric Co. This took Steinmetz to Lynn for a short period, then to Schenectady, where his notable rise and career soon gave him a country-wide and then a world-wide reputation as a mathematician, electrical engineer and author.

All this and much else about Steinmetz as child, youth, man, engineer, socialist in Breslau and in Schenectady, member of the local board of education and also of the city council, and candidate for the office of state engineer and surveyor of New York, is well narrated in this biography, which was authorized and in part written, read and approved by Steinmetz before his death, according to a Foreword by Steinmetz's adopted son and fellow engineer at the General Electric Co.'s plant in Schenectady. Not the least interesting parts of the book are the pages that tell of Steinmetz's camp on the Mohawk River, the house he built in Schenectady, the laboratories at both places, the birds, animals, cacti and other plants Steinmetz gathered, and particularly his intimate companionship with the Hayden and other children.

Steinmetz's engineering achievements are sufficiently outlined to give engineers a good general knowledge of their nature and extent without going into technicalities that would dull the interest of the general reader.

A Good Book Made Better

COMPOSITION OF TECHNICAL PAPERS—By Homer Andrew Watt, Professor of English, Washington Square College, New York University, and Philip B. McDonald, Assistant Professor of English, College of Engineering, New York University. Second Edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 5 x 8 in.; pp. 429; some line cuts. $2.

New chapters and revision of the old material, both by Professor McDonald, add to the value of this useful book, as originally written by Professor Watt. The new chapters are: (1) on Diction and Professional Style, and (2) The Campaign for Better Letters. The chapters on Engineering Reports and on Business and Professional Letters have been thoroughly revised. The hyphen has been given "retreatment." Although the book is designed for college students, there are not many engineers who would not be benefited by reading this handy little volume. The first edition was reviewed at length in *Engineering News-Record*, Nov. 15, 1917, p. 937.

Babbitt's Sewerage and Sewage Revised

SEWERAGE AND SEWAGE TREATMENT—By Harold E. Babbitt, M.S., Associate Professor of Municipal and Sanitary Engineering, University of Illinois; Assoc. M. Am. Soc. C. E. Second Revised Edition. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 516, 185 halftones and line cuts. $5.

Not every author responds so fully and cheerfully to criticisms of a first edition as has Professor Babbitt in revising his Sewerage and Sewage Treatment. Besides profiting by voluntary criticism the author "invited criticisms from all teachers and some engineers who used the first edition" and "has endeavored to meet" all responses to his request. The result is a material improvement over the first edition, itself a creditable production.

By omission and abbreviation the author has found place for new matter, chiefly in the chapters on sewage treatment, a subject of perennial change. The chief out-and-out omission is the chapter on Contracts and Specifications, called inadequate in the review of the book by Prof. John H. Gregory in our issue of April 20, 1922, p. 659. A number of other suggestions made in that review have also been followed, such as division of the former single chapters on Construction and on Filtration into three chapters each, and the adoption of a number of definitions formulated by a committee of the American Public Health Association, and an enlargement of the chapter on Dilution. A complete rewriting has been given to the chapters on Sludge and Activated Sludge. A new closing chapter contains a useful comparison of the various processes of sewage treatment. Needed corrections made include the section on non-uniform flow.

To have done all and more than has been stated and still put out a book quite a bit shorter and materially better than the first edition is a subject for congratulation.

A New Branch of Engineering

DAIRY ENGINEERING—By John T. Bowen, B.S., Engineer, Bureau of Dairying, United States Department of Agriculture. [The Wiley Agricultural Engineering Series, Edited by J. Brownlee Davidson, A. E.] New York: John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. 532; 162 line cuts. $3.75.

The supplying of milk to cities and other incidents of dairying requires a considerable variety of engineering equipment. Moderately high temperatures are required for the pasteurization which is now so largely used while toward the other end of the heat scale much refrigeration is demanded. Dairy buildings must be lighted and first and last a considerable amount of power is required at a large plant. To attain the sanitary and economic efficiency that is required in dairying today a goodly number of engineers must be employed in the design and more yet should be employed in the operation of dairies. There is also an increasing amount of sanitary inspection of dairying operations by city and local boards of health with a prospect that the federal government will, before much longer, go into inspection of the production and handling of milk passing from one state to another. Most of the health protective work relates to sanitary rather than mechanical engineering, but both the pasteurization and the refrigeration plants require careful and frequent inspection to make sure that their sanitary efficiency is not impaired.

The book before us, by no means the first one on dairying, is the first to come to our attention that deals exclusively with dairy engineering. It is devoted pri-

marily to the mechanical and electrical engineering aspects of the subject, but does treat of some of the main essentials of sanitary control. Transportation of milk from farm to consumer is not gone into. As the book is designed both for the plant operator and for use in college classrooms, its scope is comprehensive. After a good introduction in short compass and a series of definitions, the author takes up steam, steam boilers and fittings; chimneys, combustion and firing; the steam engine with piping and accessories; exhaust steam and its uses and causes of heat loss; the internal combustion engine; the transmission of power; refrigeration; insulation; electric motors, and finally temperature measurement and control.

The book gives promise of usefulness in a large and growing field.

A New Theory of Reinforced Concrete

REVIEWED BY T. D. MYLREA
Assistant Professor of Structural Engineering, University of Illinois, Urbana, Ill.

REINFORCED CONCRETE BEAMS IN BENDING AND SHEAR—By Oscar Faber, O.B.E., D.Sc., M.Inst. C.E., Consulting Engineer to The Bank of England, H. M. Office of Works, Hudson's Bay Co. London: Concrete Publications Limited. Cloth; 6 x 9 in.; pp. 149; 115 halftones and line cuts. 9 shillings net in England.

In 1916 Dr. Faber contributed a series of articles to *Concrete and Constructional Engineering* in an effort to combat certain specifications of the London County Council which he considered to be incorrect and unreasonable. These articles have been cast into book form and published under the above heading. In general the book may be said to consist of a study of tests conducted by the author to determine the reliability of the regulations in question, together with the advocating of a novel method of computing the shearing strength of beams. It is well illustrated with photographs of the failure of many of the test specimens, which merit careful study.

The author firmly believes in, and gives in his Introduction a clear presentation of, the value of tests carried to destruction. He would, in design, take into consideration not only the elastic limits of the component materials but also the ultimate strength of the composite member itself. Therefore, in his tests, the safe load of the specimens is calculated by the formulas which it is sought to test, and by comparing this with the experimental ultimate load, factors of safety are determined, and, from these, the relative reliability of the formulas.

The regulations to which the author objects most seriously are those governing the design of compression reinforcement and those concerning shear. The London County Council states: "In cases where the compressive resistance of the concrete is not taken into account, the stress in the compressive reinforcement may be taken at 16,000 lb. per sq.in., on condition that sufficient steel is provided to take up the whole of the compression," etc. The author claims that although this newer method of computing the required amount of compression steel may be more economical, its justification is doubtful; and he supports the usual method of adding to the compression in the concrete an amount equal to "n" times the area of the steel multiplied by the stress in the surrounding concrete. From his tests he reaches the conclusion that the allowable load, thus computed, for beams with varying percentages of tension and compression steel has a more nearly constant factor of safety on the ultimate load of his test beams than has the allowable load as determined by the L.C.C. regulations, and concludes, therefore, that the older method not only approximates more closely the actual condition in a beam, but is consistently safer.

The most vigorous attack is on the regulations governing shear, which are quite similar to those of our own Joint Committee. He contends that in actual construction a large part of the shear is resisted by "Inclined Compressions." For example, he considers that in a simple beam with a central concentrated load, an inclined compression carries the load in a direct line to each support, and that it is there resolved into a vertical component constituting the reaction and a horizontal component which must be taken care of by an efficient hook or other fastening. The member in reality is thus considered as an arch with a tie rod. Bond is entirely ignored, on the ground that when failure is impending, bond is practically destroyed, and that the end anchorage of the through bars must then develop the full tensile stress in them. Where beams are reinforced for shear by means of stirrups or bent bars, the theory is extended to include indirect inclined compressions and indirect compression systems superimposed, thus forming imaginary Warren trusses, Howe trusses and combinations of both. Approximately the last half of the book is given over to the discussion of tests of T beams, continuous beams and rectangular beams, which, the author claims, prove the correctness of the method.

While the author has broken away from traditional teaching with regard to shear, and is to be commended for his efforts to introduce a new line of thought, there are places in the work in which the reasoning does not seem at all satisfactory. For example, while the idea of inclined compressions may have some merit, allowing an increase of 50 per cent in the permissible shear, because top steel is placed over the supports in a simple beam, is carrying a number of assumptions and unproved statements to an unwarranted extreme. In another place he concludes that since the shear in one of his test beams, when failure occurred, was but three times the "usual working stress" of 60 lb. per sq.in., while the compression was 4.92 times as high as the "usual working stress" of 600 lb. per sq.in., failure occurred by compression and not by shear. The fact, however, that a "usual stress" may not be the correct allowable one, leads to serious confusion in the deductions. If we were to adopt, for example, the "usual working stresses" of the Illinois State Highway Commission of 40 lb. per sq.in. in shear and 1,000 lb. per sq.in. in compression, it could just as readily be shown that failure occurred by shear and not by compression.

Similar reasoning is found in several places throughout the work, and is particularly objectionable in discussing beams reinforced in compression. The tension in the steel in all these test beams at failure was well above the elastic limit, so it is probable that in the beams reported as failing in compression, the compression failure was actually a secondary phenomenon. Failures of reinforced-concrete beams, due primarily to compression, are rare.

The amplification of the theory of direct inclined compressions to include the case of continuous beams is thoroughly fallacious. For example, in continuous beams, where the top reinforcement does not extend beyond the point of contraflexure, the author admits

that no shear may be resisted by direct inclined compressions, and then assumes that if the top steel be extended continuously through the spans, the difficulty disappears. Again, while direct inclined compressions of necessity make arches of simple beams, he refuses to consider a line of continuous arches when applying the same theory to a continuous beam, and attempts to confine his discussion to a beam. He then makes the horizontal component of the inclined compression equal to the sum of the beam tensions in the member, and hence it should follow that at the point of contraflexure, where the beam tension is zero, the inclined compression should also be zero.

Thus, while the whole work is enticing in its novelty of treatment, and while the tests at first glance appear to bear out the author's theory of inclined compressions, one cannot avoid the feeling of great uncertainty as to the accuracy of the proofs, and is left with the impression that the tests show the utility of the method for the few beams tested rather than its correctness and general applicability.

Scientist, Patriot, Humanitarian

THE LIFE OF PASTEUR—By René Vallery-Radot. Translated from the French by Mrs. R. L. Devonshire. With an introduction by Sir William Osler, Bart., M.D., F.R.S., Regius Professor of Medicine, Oxford University. Garden City, N. Y.: Doubleday, Page & Co. Cloth; 6 x 9 in.; pp. 484; frontispiece portrait; index. $3.

After reading Mrs. Devonshire's translation of Vallery-Radot's able and entertaining life of Pasteur and rereading the appreciative Introduction by the late Sir William Osler one hardly knows whether to admire Pasteur most as scientist, patriot or as a devoted servant of humanity. Not that these three exhaust the list of Pasteur's outstanding achievements and objects of devotion. His family relations and his many personal friendships were remarkable. He was not only an outstanding teacher and lecturer but also an ardent promoter of educational progress. Before passing to the book itself it is a pleasure to note how completely the biographer enters into the life of his subject and into those branches of science to which Pasteur devoted himself. Not least among the good features of the book is that it portrays a great Frenchman and his devotion to France as could be done by no other than a Frenchman.

After notable researches in crystallography, professorships in physics at Dijon and in chemistry at Strassburg, and intensive studies of racemic acid, Pasteur became Dean of the new Faculty of Sciences at Lille. Here, on an appeal from a manufacturer of beet-root alcohol, Pasteur began his studies of fermentation which were to be not only of immense benefit to industry but also, in connection with later studies designed to prove or disprove spontaneous generation, were to mean so much to preventive medicine, as applied to the communicable diseases of animals and men. Mention need be made only of Pasteur's triumphs with diseases of the silkworm, of wine and beer, with anthrax, hen cholera, swine fever and, last but not least, rabies.

Through all these years, much of Pasteur's time and energy went to answering those who denied his claims and achievements. The disputants included scientists, real and pseudo, veterinarians and physicians, who resented what they considered to be encroachments on their fields by a "chemist" or "microbist." Among the disputants was Liebig. Thirteen years after Liebig's denials of Pasteur's claims, the latter seized an opportunity to visit the German chemist. "Liebig," Pasteur thought, "could not still be affirming that the presence of decomposing animal or vegetable matter should be necessary to fermentation." Liebig received Pasteur with "kindly courtesy" but when the latter "tried to approach the delicate subject, Liebig, without losing his amenity, refused all discussion, alleging indisposition." Koch, although at one time rather scornfully critical of Pasteur, eventually gave the latter due recognition.

As early as 1873 Pasteur was admitted as a "free associate" of the French Academy of Medicine—but with only one vote to spare although "first on the section's list." Later he became one of the forty immortals of the French Academy, on which occasion he was gracefully welcomed by Renan. Long before, as fellow members of the Academy of Sciences, Pasteur and the great French critic, Sainte Beuve, had been intimate. Many other facts might be noted to show the range of Pasteur's interests, intimacies and the recognition he had from learned men and societies.

No more untiring worker for scientific truth, for country and for humanity ever lived than Pasteur. This life, as Dr. Osler well says, is "for young men of science, and for others who wish to learn what science has done and may do for humanity." From the book, says Dr. Osler, three lessons may be learned: "The value of method, of technique, in the hands of a great master has never been better illustrated. . . . In the life of a young man the most essential thing for happiness is the gift of friendship. . . . And the last great lesson is humility before the unsolved problems of the universe"—including recognition and reverence for, to use Pasteur's own words, "the inevitable expression of the Infinite in the world."

PUBLICATIONS RECEIVED

A RECORD OF THE STRESS MEASUREMENT WORK on four steel columns of the Equitable Building in Des Moines, Iowa, has been published as Bulletin 72 of the Engineering Experiment Station, Iowa State College (Ames, Iowa). Prof. A. H. Fuller is the author. The data covered by the report are identical with those presented in *Engineering News-Record* of Oct. 2, 1924, p. 540, but are somewhat more complete.

UNDER THE TITLE "Steel Construction" the American Institute of Steel Construction (Cleveland, Ohio) publishes in pamphlet form its specifications for structural steel for buildings, first made public nearly two years ago, and its code of standard practice, adopted last fall. With these documents are given some convenient diagrams and table of allowable loads and deflections.

TESTS OF DURALUMIN TUBING have been reported by the air service of the U. S. Army as Air Service Information Circular (Aviation) No. 478 (Washington, D. C.). The circular includes tests of tubes up to 2¼ in. in diameter and ⅛ in. of wall thickness, as columns, as short pieces in compression, and as torsion members. The results are unusually consistent for this relatively new material.

PAINT BUYERS AND USERS will find a set of valuable notes on paint materials and application in Technologic Paper 274 of the Bureau of Standards (Washington, D. C.) in which P. H. Walker and E. F. Hickson discuss "Use of United States Government Specification Paints and Paint Materials."

COMPARATIVE COSTS of electrical and steam operation on the Rocky Mountain, Missoula, and Coast Divisions of the Chicago, Milwaukee & St. Paul Ry., are given in a pamphlet published by the railway company. The figures are of

special interest on account of the fact that this railway electrification is the most extensive in existence. The report was abstracted in *Engineering News-Record*, March 5, p. 411.

FEATURES OF THE PROPOSED ORDINANCE for a comprehensive local transportation system in Chicago are given in a pamphlet prepared by the corporation counsel of the city. This is the ordinance which, with certain modifications, was passed on Feb. 27, 1925.

PLANS FOR RAPID TRANSIT in Pittsburgh, Pa., are presenter in a report of the Bureau of Traffic Relief of the City, entitled "Report on a Recommended Subway in the First and Second Wards of Pittsburgh, or Proposed First Step in a Rapid Transit Program."

STATE-WIDE CHEAP POWER for Pennsylvania is proposed in the report of the Giant Power Survey Board, issued at Harrisburg, Pa., in February. This report was abstracted in *Engineering News-Record*, Feb. 26, p. 365.

WATER POWER INVESTIGATION OF THE DEEP RIVER has been published in pamphlet form by the North Carolina Geological & Economic Survey as Economic Paper No. 54. The stream under consideration is relatively small, but as the investigation has gone into its development as a source of power in relation to the Deep River coal field the study is of considerable interest. A feature of the investigation made by the survey was that of reducing silting and methods of removing silt from reservoirs. The method proposed was described in *Engineering News-Record* Aug. 21, 1924, p. 306, in abstract from proofs of this paper on the Deep River.

ARGUMENTS AGAINST COMPULSORY ADOPTION of the metric system, grouped under various industries that would thus be caused great trouble and expense, have been brought together in a small illustrated pamphlet, Our American System of Weights and Measures: Why We Should Keep It. (American Institute of Weights and Measures, 115 Broadway, New York City.)

A SYMPOSIUM on The Effect of Temperature Upon the Properties of Metals, consisting of papers and discussions at the Cleveland joint meeting of the Am. Soc. C. E. and Am. Soc. T. M., has been reprinted from the copyrighted proceedings of the two societies and put on sale by the latter. (American Society for Testing Materials, 1315 Spruce St., Philadelphia. $1.50 per copy up to 10 copies; $1 in lots of 10 to 50; $0.75 for lots of 50 to 100 copies.)

COLORADO RIVER PROBLEMS are discussed by G. E. P. Smith, irrigation engineer, Arizona Agricultural Experiment Station, in a 32-p. bulletin supplementary to an earlier bulletin on the same stream. Some of the topics are: Legal rights of Arizona in the Colorado River; water laws of Arizona; relative rights of agriculture and power; low season flow; irrigable lands and water supply; and the outlook for hydro-electric power.

REBUILDING OUR CITIES FOR THE MOTOR AGE, a paper by Morris Knowles, chairman City Planning Commission, Pittsburgh, Pa., a paper read last October before the Safety Congress at St. Louis, is available in pamphlet form; also a report on city planning made for the City Planning Commission of Canton, Ohio.

AMONG THE PAPERS on the Biology of Sewage Disposal making up the third annual report of the Sewage Substation of the New Jersey Agricultural Experiment Stations (New Brunswick, N. J.) are two on studies dealing with the operation and resting of Imhoff Tanks, one taking up chemical studies, by F. Leslie Campbell and Willem Rudolfs, and one summarizing bacterial studies, by Marget Hotchkiss. Other papers deal with sludge digestion, the fauna of Imhoff tanks and sprinkling filters and film removal.

A REDUCTION IN PRICE from $4.50 to $4 of the Proceedings of the London Conference on Sanitary Engineering, 1924, noted briefly in these columns on Feb. 19, p. 329, deserves mention. The American Public Health Association (370 Seventh Ave., New York City), sole agent for the book in the United States, has decided to sell it for the lower price mentioned above. The volume contains many papers by foreign and American authors on sewerage and sewage disposal, including the activated-sludge process, on public health and sanitary administration and some other topics. A descriptive circular may be had from the American agent.

PAMPHLET REPORTS published by the City Plan Commission of Toledo, Ohio, deal with major streets, transit, railroad transportation, the port, an industrial survey and general progress of the commission's work. The city plan engineer employed by the commission is Harland Bartholonew, St. Louis, Mo. Myron D. Downs is resident engineer.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

CONCRETE MAKING MACHINERY. Including Appliances and Plant for Testing and Preparing the Constituent Materials and for the Distribution of Mixed Concrete—By W. Noble Twelvetrees, M. I. Mech. E., A. M. I. E. E.; Past President of the British Section of the French Society of Civil Engineers, Past President of the Society of Engineers (Inc.), and of the Civil and Mechanical Engineers' Society. [The Broadway Engineering Handbooks, Volume XXXV.] London: Scott, Greenwood & Son. American Distributors: D. Van Nostrand Co., New York City. Cloth; 5x7 in.; pp. 180; 88 halftones and line cuts. $3.50.

After discussing the selection, testing and preparation of materials for concrete and the appliances for concrete and the appliances that may be used for the preliminaries indicated, the author describes concrete-mixing machines and plant used in England, which, the book indicates, are much like those employed in America.

THE DESIGN OF CRANES AND HOISTS (Including the Construction and Design of Details of Lifting Tackle)—By Hermann Wilda. [The Broadway Engineering Handbooks: Volume VI.] Translated from the German and Adapted to British Practice. Second Revised English Edition. London: Scott, Greenwood & Son. American Distributors: D. Van Nostrand Co., New York City. Cloth; 5x7 in.; pp. 159; 399 line cuts. $2.50.

Many details of lifting tackle of fixed and movable cranes and hoists are given in this handy little volume which is now in its second revised edition. The illustrations are unusually numerous, there being 400 in the 155 pp. of text.

ECONOMICS OF BUSINESS CYCLES—By Arthur B. Adams, Ph.D., Dean of the School of Business and Professor of Economics, University of Oklahoma. New York and London: McGraw-Hill Book Co. Cloth; 6x8 in.; pp. 268; 10 charts. $2.50.

FAHRLEITUNGSANLAGEN FÜR ELEKTRISCHE BAHNEN—Von Fr. Wilh. Jacobs. München und Berlin: R. Oldenbourg. Paper or cloth; 7x10 in.; pp. 290; 400 halftones and line cuts. Paper: 12 marks, cloth, 10.5 marks, gold, in Germany.

GUIDING PRINCIPLES OF PUBLIC SERVICE REGULATION, Volume One—By Henry C. Spurr, Editor of Public Utilities Reports. Rochester, N. Y., and Washington, D. C.: Public Utilities Reports, Inc. Cloth; 6x9 in.; pp. 752; Table of Cases Cited; full index. $7.50.

JOHNSON'S MATERIALS OF CONSTRUCTION—Rewritten by M. O. Withey, Professor of Mechanics in the University of Wisconsin, and James Aston, Metallurgist with the A. M. Byers Co. of Pittsburgh; Edited by F. E. Turneaure, Dean of the College of Engineering of the University of Wisconsin. Sixth Edition. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. 865; line cuts and halftones. $6.

MANUAL OF OFFICE PRACTICE FOR THE ARCHITECTURAL WORKER: A Concise Tabulation of Instructions Covering the Routine of an Architectural Office, for the Information of the Workers Therein and All Others Having to Do with Building Construction—By Frederick J. Adams, A. I. A. (Revised and Enlarged from the version compiled by the same author for use in the office of McKim, Mead and White.) New York: Charles Scribner's Sons. Cloth; 5x8 in.; pp. 96; 5 pp. forms. $1.25.

Addressed primarily to the younger architect, but contains much information on zoning and building code regulations in which the engineer also might well be interested. Administrative work also equally interesting to engineer and architect is covered in separate chapters on estimates, contracts and payments.

PRINCIPLES OF CITY LAND VALUES—By Richard M. Hurd, President, Lawyers Mortgage Co. New York: *The Record and Guide*. Fourth Edition. Cloth; 6x9 in.; pp. 159; many halftones, charts and maps. $3.50.

An appreciative notice of this useful book, which is closely related to the city planning, appeared in *Engineering News*, March 17, 1904. The volume has reached a fourth printing but shows no changes except a brief new preface, in which the author expresses continued belief in the basic principles laid down two decades ago.

RAILWAY TRANSPORTATION: Principles and Point of View—By Sidney L. Miller, Ph.D., Assistant Professor of Economics, University of Wisconsin. Chicago and New York: A. W. Shaw Co.; London: A. W. Shaw & Co., Ltd. Cloth; 6x8 in.; pp. 905; maps, charts, tables, index. $4.

ÜBER KOSTENBERECHNUNG IM TIEFBAU, unter besonderer Berücksichtigung grösserer Erdarbeiten—Von Dr.-Ing. Heinrich Eckert. Berlin: Julius Springer. Paper; 6x9 in.; pp. 120; line cuts and tables. Paper, 6 marks, cloth, 7 marks, gold, in Germany.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Reynolds' Formula for Flow of Water in Pipes

Sir—In your issue of Dec. 18, 1924, p. 1004, R. E. Horton, in reviewing Swindin's "Modern Theory and Practice of Pumping," speaks with more respect of Reynolds' formula for the flow of water in pipes than is usual with American hydraulic engineers, but still seems to feel that the results of Saph and Schoder's experiments point in a somewhat different direction. In 1914 I took as the subject of my C.E. thesis at Cornell "The Flow of Water in Straight Pipes." Saph and Schoder's data were by far the most accurate I could find, and I tried to devise a formula that would fit the data (including the effect of variations in temperature). Much to my surprise I discovered that Reynolds' formula agreed with their results with a remarkably small average error. In fact their data proved Reynolds' formula very much better than the results of his own experiments. Reynolds' formula differs from the other exponential formulas in that it rests on a rational basis and was derived mathematically. It may be put as follows:

$$H = \frac{c\,V^n}{D^{3-n}}$$

where H = the loss in head in feet per 1,000 ft., V = the mean velocity in feet per second, D = the diameter of the pipe in feet, n = a constant depending only on the roughness of the pipe, and $c = a(b\nu)^{2-n}$ where ν is the kinematic viscosity in c.g.s. units and a is a constant depending on the roughness and b is an absolute constant necessary to change from c.g.s. to English units. The formula gives the exponent of D as $3-n$, that is, the sum of the exponents of V and D is always 3. Most American authorities have followed Saph and Schoder in making the exponent of D fixed at 1.25. As a matter of fact I believe they obtained 1.25 simply because they were dealing with brass pipe for which $n = 1.75$. The point is quite fully treated in Scobey's paper on "The Flow of Water in Wood-stave Pipe" (U. S. Dept. of Ag. Bull. No. 376, pp. 88 and 94). I give below a list of value of the exponents of V and D as found by various experimenters (when their formulas are solved for H as above):

Authority	Exponent of V	Exponent of D	Sum of Exponents
Lampe	1.80	1.25	3.05
Flamant	1.75	1.25	3.00
Williams	1.87	1.25	3.12
Williams-Hazen	1.852	1.167	3.019
Moritz	1.80	1.26	3.06
Scobey	1.803	1.17	2.973

It will be seen that the general tendency is for the sum of the exponents to be 3 as the Reynolds theory shows it should be. For example Scobey's formula could be changed to $H = \frac{0.42\,V^{1.81}}{D^{1.19}}$ and still fit his data with practically the same average error. His results are very much to the point in this connection as (including the work of Moritz) they are based on a range of D from 0.333 to 13.5.

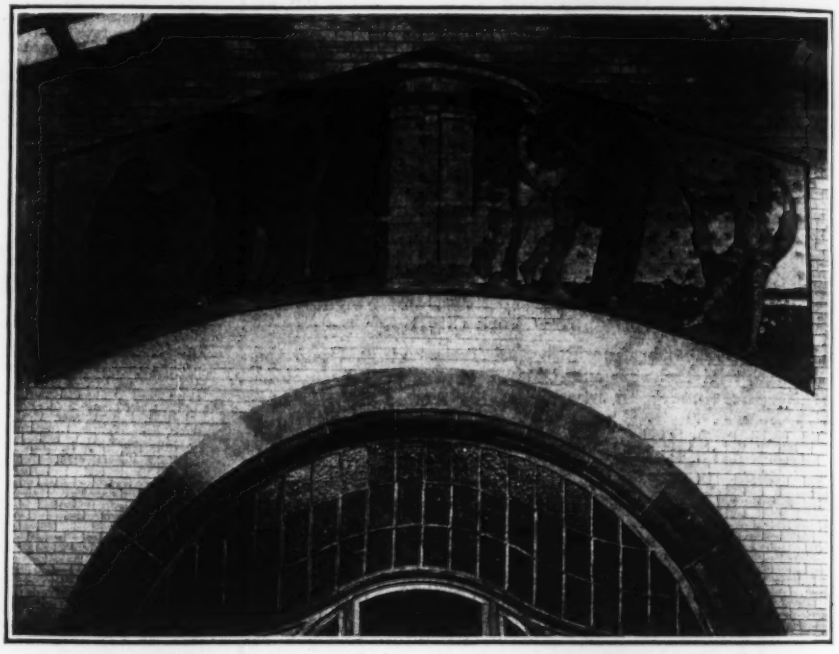
For very rough pipes n is nearly 2 and therefore temperature has very little effect on the resistance, but for smooth pipes the values are much less (about 1.68 for lead, 1.75 for brass and 1.81 for wood). In none of these cases can the effect of changes of temperature be neglected if accurate results are required. I believe that the neglect of this factor is responsible for some of the lack of agreement in the results of experiments on pipe flow.

Changsha, China, Feb. 2, 1925.

RALPH W. POWELL,
College of Yale in China.

Mural Decoration in Entrance Hall of Frankfort Sewage-Works

Sir—Herewith is a photograph of a mural decoration in the entrance hall of the sewage-works of Frankfort, Germany. The painting presents allegorically the purification of sewage in the treatment works: The dirt and disease-laden water, represented by wan and haggard old women clad in sombre raiments, entering the plant and being rejuvenatel as in the Fountain of Youth to leave the works in clear and pure condition, represented by the beautiful young women, who are stepping out into sunlit atmosphere. The mural decoration impressed me when I visited the plant some time ago and I recently received the photograph of it which I enclose for reproduction in your columns as an example of the artistic possibility that can be realized in a structure that commonly would not appeal to the aesthetic sense. The Frankfort sewage-works were designed by the English engineer, Lindley.



ALLEGORICAL MURAL DECORATION, FRANKFORT SEWAGE-WORKS

GORDON M. FAIR,
Instructor in Sanitary Engineering,
Harvard University.
Cambridge, Mass., February 23, 1925.

Public Buildings Office Duties Enlarged

The office of Public Buildings and Grounds, so well known in the national capital, has become the "Office of Public Buildings and Public Parks of the National Capital." The new title is provided in the recently enacted statute which also designates the head of the office as "director" instead of superintendent. The new law adds to the duties of the director those formerly performed by the superintendent of the State, War and Navy Buildings. The director still is to be chosen from the Corps of Engineers as formerly.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Sanitary Surveys of Oyster Supply To Be Made by U.S.P.H.S.

Washington Correspondence

Plans for the sanitary survey of the oyster beds of the United States and other work in connection with the oyster supply, considered necessary as a result of the recent alleged oyster-borne typhoid outbreaks in several cities and the conference of fishermen, dealers and state and local health authorities with federal officials at Washington on Feb. 19, are being worked out by the U. S. Public Health Service. As the inspections and studies are to be conducted in co-operation with state officials, communications have been sent all of the latter affected by the campaign preliminary to perfecting final arrangements.

The Public Health Service was given $57,600 for special work in connection with oysters in the second deficiency appropriation bill, the last measure which was enacted by the Sixty-Eighth Congress.

The appropriation states that work is to be conducted by the Public Health Service in co-operation with the Bureau of Chemistry, Department of Agriculture, and the Bureau of Fisheries, Department of Commerce. The field work will be conducted by the Public Health Service until such time as it may become necessary to call upon the other bureaus for advice and assistance.

The general plan is first to make tests of the water and other conditions at the oyster beds, inspect the plants and methods of handling the bivalves, and test the drainage areas tributary to the beds and waters. Later, it is probable there will be a general study of sewage disposal as affecting the beds, together with other subjects of a pertinent nature. Until the suggestions are received from the state authorities, however, the full plan of operations will not be worked out.

Dr. William P. Draper, assistant surgeon general, has administrative charge of the oyster work. Dr. H. E. Hasseltine has been designated to have immediate charge of the work. Sanitary Engineer R. E. Tarbett has been ordered to Washington from the field to have charge of the sanitary engineers assigned to the oyster investigations.

U. S. St. Lawrence Board Meets

While the American members of the Joint Engineering Board now have at their disposal the recently appropriated $275,000 for borings and other work on the St. Lawrence, definite plans must await some further progress in the negotiations. The American members of the Board are meeting in Detroit this week to discuss the situation and to inspect certain areas on the river.

Engineering Fifty Years Ago

From *Engineering News*, March, 1875

WE have no system of technical instruction in this country adapted to the wants of the people at large. How this want can best and most quickly be met, without detriment to our existing public school system, is a question which we think should receive the attention of those who make educational problems a study. There is nothing impracticable in the idea of a system of scientific and technical instruction which shall be practically free to all who wish to avail themselves of the facilities offered. Great polytechnic schools like those of Europe, are not to be looked for as the first fruits of a movement in this direction. Let us first have free evening classes and lectures in suitable buildings, to which young mechanics are invited. Under the charge of competent professors these classes would accomplish great good, and out of such a beginning would soon grow a system of public instruction well calculated to elevate the standard of intelligence among our working classes, and encourage a taste for reading and study on the part of young men who can be made to appreciate the advantages of education in no other way.

Lieut.-Col. Slattery Accepts Post With N. Y. Transportation Board

Lieut.-Col. John R. Slattery, Corps of Engineers, and for the past two years district engineer of the first New York district, has been appointed deputy chief engineer of the New York City Board of Transportation. Lieutenant-Colonel Slattery has accepted the appointment and will enter upon his new duties April 1. He will resign from the Corps of Engineers, though he is not eligible to apply for retirement, under Army regulations, until June 14, 1926. His resignation is the result of Secretary Weeks' refusal to grant a leave of absence on the grounds that it is contrary to good military policy.

Lieutenant-Colonel Slattery is a graduate of West Point, class of 1900. During the World War he commanded the 312th Engineers. During 1918 and 1919 he was in charge of the 7th Army Corps. Following his recovery from pneumonia in 1920 he engineered the Columbia River improvement below Vancouver. He has served as district engineer at New York since Feb. 26, 1923 and has had wide experience in river and harbor work both in this country and the Philippines.

He will receive a salary of $10,000 a year.

A.R.E.A. Annual Meeting Covers Wide Field

What to Do With Association Funds—All Committee Reports Handled —Medals Presented to Engineers

Engineering News-Record Staff Report

Budgeting railway maintenance-of-way expenditures over a term of years in order to maintain a reasonable standard condition of the property, instead of reducing these expenditures whenever there is a temporary drop in traffic, was one of the strong points urged by George J. Ray, chief engineer of the Delaware, Lackawanna & Western R.R, in his presidential address at the annual meeting of the American Railway Engineering Association, held at Chicago on March 10 to 12. Study of highway diversion as a means of eliminating grade crossings was also advocated, Mr. Ray suggesting that in one season the railroad engineers could make a reconnaissance survey of the entire country and record the location of all crossings which could be eliminated by diverting the highways. In such work he favored a movement to convince public authorities of the advantage of co-operation with the railroads.

The report of the secretary noted some of the high points of the Association's work, and showed a membership of 2,227 (of whom 1,520 are engineering officers), as against 2,149 a year ago. Receipts totaled $55,738 and expenditures $45,534, the balance on hand being now $54,430. In view of this large amount, the president in his address suggested that the board of direction should give careful consideration to the best use to be made of the accumulating funds.

New Methods Advocated

In a speech at the annual dinner, F. H. Alfred, president of the Pere Marquette R.R., chided the railroad engineers for their conservativeness in regard to the introduction of new methods and new appliances. He suggested that a bureau of research supported by the railroads in general should be organized and that its first work should be the design of a permanent roadbed.

It may be recalled that approximately two years ago the engineers were criticised by Mr. Aishton, president of the American Railway Association, for their slowness in adopting the very standards which they, as members of the association, have developed.

Reports from all the 24 committees were printed in advance, covering nearly 1,200 pages. Each report was presented and considered but much of the material submitted was in the form of information or progress reports, so that in the discussions there were few points of constructive development or

of controversy. There is still an evident overlapping of committee work and a tendency to disregard the frequent cautions as to the desirability of conciseness and careful consideration of the material presented. It was notable that very few of the committees presented any report on their own initiative or responsibility; each one presented a number of reports of sub-committees and it is not apparent whether more than perfunctory consideration had been given to these by the parent committees. This condition seems inevitable while the association adheres to its policy of assigning a long list of subjects to each committee.

A feature of interest was the presentation of two bronze medals: to Earl Stimson, senior past-president, who now retires from the board of direction after eleven years' service, and to Prof. A. N. Talbot, in recognition of his valuable research work on stresses in railway track. At one session memorial addresses were presented regarding the late A. W. Johnston, general manager of the New York, Chicago & St. Louis Ry., and H. T. Douglas, Jr., chief engineer of the Chicago & Alton Ry. J. M. R. Fairbairn, chief engineer of the Canadian Pacific Ry., was elected president; C. F. W. Felt, chief engineer of the Santa Fe Ry. System, moves up from second to first vice-president, and Daniel J. Brumley, chief engineer of the Chicago terminal improvements of the Illinois Central R.R., was elected second vice-president. Geo. H. Bremner, treasurer, and E. H. Fritch, secretary, were both re-elected. The registered attendance at the meeting was 988 members and visitors.

Work and Mead Visit Western Reclamation Projects

The Secretary of the Interior is making a western trip with the idea of gathering first-hand data concerning reclamation projects and the national parks. He is accompanied by Dr. Elwood Mead, the Commissioner of Reclamation, and Stephen T. Mather, the Director of the National Park Service. While no exact itinerary has been fixed at this writing, the plan is to visit the Carlsbad reclamation project on or about March 25. March 27 probably will be spent at the Elephant Butte dam and vicinity. The first of the following week will be spent at Yuma, after which the Sequoia National Park will be visited. En route to the Klamath project a short stop will be made at Merced. Afterwards the Orland and Durham projects will be visited. A day will be spent on the Newlands project. On the way to Denver a stop will be made on the Uncompahgre project.

City Manager Plan Advised for Rochester, N. Y.

An outline of a model city charter for Rochester, N. Y., has been submitted to public consideration by the Rochester Bureau of Municipal Research. The recommendations are for commission of 9 or 11 members, a city manager, and as limited a number of executive departments as feasible.

Light on Trade Association Scope Hoped For in Cement Decision

Washington Correspondence

Trade association executives are hopeful that the United States Supreme Court will render a decision in the cement case, which has been submitted it, that will clarify the legal haze surrounding the scope of association activities in the field of statistics.

The appeal of the Cement Manufacturers' Protective Association, four individual officers and 19 cement manufacturing corporations which were members from a decision by Judge Knox in the Southern New York district court, granting an injunction sought by the government and holding that the association's activities, particularly in collecting and distributing statistics, constituted restraint of trade, was argued before the high court the first week in March. Among attorneys appearing for the association was John W. Davis, democratic nominee for President in the last campaign.

The argument in behalf of the association and its members revolved chiefly around the contention that the lower court erred through misunderstanding of business aspects of the cement industry and the scope of the activities of the association. It was contended that the association distributed data as to orders only for those designated "specific job contracts." This was done, the court was told, because of the contractors, who have no obligation to actually purchase on such future-delivery contracts, duplicating their orders. In such cases as where several contractors submit bids for a job all may enter orders for the cement necessary while only one will call for delivery.

The association was organized to protect its members from legal and economic wrongs and had no activities capable of producing restraint of competition, it was argued. On the other hand, attorneys for the government argued the association tended to restrain competition and that prior to its organization there had been a "cut-throat price war" which ended as soon as the association was formed.

Pennsylvania Constructors Hold Annual Convention

A healthy growth in number and quality of members was reported by the Associated Pennsylvania Constructors at their annual convention in Harrisburg, Pa., March 13 and 14. There are now about 150 general contractors and building contractors in the organization and its finances are in excellent condition. Three sessions were held and, on the evening of March 14, a dinner at which brief addresses were made by George D. Walbridge, president, Associated General Contractors; S. M. Williams, vice-president, Autocar Co.; Hon. Gifford Pinchot, governor of Pennsylvania, and Hon. Samuel S. Lewis, auditor general of Pennsylvania.

The opening session was occupied largely in receiving reports of the standing committees on legislation, labor, materials, contracts and specifications. A paper by H. H. Wilson on "Four and One-Half Years of Organization in Pennsylvania" and brief talks by Mr. Walbridge and Frank C. Wight followed. The second session disclosed considerably more interest in the discussion of quantity surveys and licensing contractors by D. H. Sawyer and on day labor construction by Mr. Walbridge. The discussion of all three subjects was general and active. A resolution was passed dissenting with the licensing of contractors and another protesting against the five-day week advocated in certain building trades.

Lea Hunt of Wilkes-Barre, Pa., was re-elected president.

Chicago A.A.E. Endorses Council Plan for Unified Subways

Approving the general plan for developing the transportation system of the city of Chicago by the extension of the existing system and the addition of subways, the Chicago metropolitan chapter of the American Association of Engineers at a meeting on March 10 endorsed the efforts of the Chicago city council and the ordinance prepared by the council, and recommended to the voters of the city that the ordinance be approved at the polls on April 7, when it will be voted on The Chicago metropolitan chapter has about 700 members.

Francis X. Busch, corporation counsel of Chicago, explained to the meeting the meaning and limitations of the ordinance and in an open discussion lasting more than two hours many ideas for and against the proposition were advanced, about twenty members taking part in the discussion. It seemed to be the consensus of opinion that a matter of one or two cents more or less in the rate of fare was of small importance in comparison with the value of greatly improved transportation facilities.

By terms of the ordinance the city assumes no financial obligation for the construction of the new system and extensions of the old one but the title to the system is vested in the city and a unified system and universal transfers are provided. The control of operation is in the hands of a board representing the city, the security holders and a neutral group.

The chapter's resolution contained the following recommendations: That (1) elevated extensions be located in alleys or private ways; that (2) politics be eliminated in the operation of the system; and that (3) subway plans be made more adequate.

N. Y. State Assembly Considers Trans-Champlain Bridge

The New York State Assembly on Feb. 17 by unanimous vote adopted a resolution introduced by Assemblyman Fred L. Porter, republican of Essex County, to create a legislative committee to investigate the feasibility of constructing a highway bridge across Lake Champlain between New York State and Vermont. The resolution carries an appropriation of $5,000. Vermont already has authorized such an inquiry.

Construction to Start Soon on Arch Test Dam

Construction of the experimental arch dam to be built in southern California under the direction of Engineering Foundation's arch dam committee will start shortly, as subscriptions in excess of $60,000 toward the project are in hand. More funds will be needed to carry the proposed studies to final completion, since a total of $100,000 is desired for raising the dam to its ultimate height and completing the tests; the funds so far subscribed will suffice for the first series of tests, however. Of the present total of $61,700, the latest item is the sum of $15,000 from the supervisors of Los Angeles County, acting for the flood control district. Cash subscriptions were received from 18 contributors, and the California Cement Co. donated an amount of cement sufficient for the dam.

City Must Pay for Bridge Repairs

A decision just rendered by the special master of the Massachusetts Superior Court on the subject of repairs to the Hampden County bridge over the Connecticut River at Springfield, Mass., has just held that the city, not the county, must pay for the repairs. The case arose from an accident on Sept. 9 last, when a taxicab knocked out a section of railing (see Nov. 20, 1924, p. 846) and an engineering investigation following, which found the railing too weak and the curb too low (see Jan. 29, 1925, p. 200). The city in its petition to the court contended that the inadequacy of the curb and the weakness of the balustrade were defects in the original design and construction, so that the county should remedy these weaknesses, although it is conceded that the city is responsible for paying for repairs to the bridge.

Moffat Tunnel Progress

Progress up to Feb. 12, 1925, on the six-mile Moffat Tunnel, in Colorado, with its double parallel bores, is tabulated below, and is shown graphically on the accompanying drawing.

	East Portal	West Portal
Pioneer or water tunnel	8,000 ft.	6,400 ft.
Main tunnel headings	7,880 ft.	5,740 ft.
Cross cuts	315 ft.	315 ft.
Main tunnel completed	4,550 ft.	1,020 ft.

About Feb. 15 the east heading of the pioneer tunnel, which is now directly under Crater Lake and 1,350 ft. below it, developed a flow of about 1,800 gal. per minute.

Railroads Urged to Aid in Reclamation Development

Railroad representatives are meeting at the Congress Hotel, Chicago, today (March 19) with Dr. Elwood Mead, director of the Bureau of Reclamation, to discuss plans for any transportation betterments necessary to move settlers and develop farms in connection with reclamation projects under construction, approved for construction and for which surveys have been authorized.

The Secretary of the Interior has issued a statement embodying data on the need for co-operation between the federal government and state governments, railroads and agricultural and commercial organizations. These data estimate the completed cost of all projects (fourteen) included in the above classification at about $105,000,000 and the complete or partial acreage that will become available in a few years at almost 600,000, this amount split up into 40 to 160-acre tracts, with the average-sized tract containing 80 acres.

The Secretary also emphasizes the need for settlers on old tracts, the amount of acreage available within the next few years being given as 550,570, or more than 9,000 settlers per 60-acre farm.

The particular co-operation which the railroads can offer is set forth by Secretary Work as follows:

"Letters from project superintendents on existing projects show, in a number of instances, that nothing will contribute more to settlement and agricultural development than short railway extensions to better serve the projects."

Los Angeles Building New Dam in San Francisquito Canyon

A simple gravity arch concrete dam is being built by the Los Angeles Water and Power Bureau between power plants No. 1 and No. 2 of the Los Angeles aqueduct in San Francisquito Canyon. This dam, scheduled for completion early next year, will develop a storage capacity of 38,000 acre-ft. which can be used in years of heavy runoff to save water that would otherwise be wasted. Water collected in this reservoir can be turned back into the aqueduct at San Francisquito No. 2 power house.

The structure will have a total height of 205 ft. over all and will contain 140,000 cu.yd. of concrete. It will resemble in many respects the Weid Canyon dam, completed by this department last year in the hills above Hollywood.

Pennsylvania Legislature Has $50,000,000 Road Bond Bill

Resolutions have been introduced into both houses of the Pennsylvania State Legislature proposing the authorization of an issue of $50,000,000 in road bonds for state highway construction. This bill proposes to make available money for highway construction before the present bond issue of $50,000,000 has been exhausted. Before the bonds can be issued the resolution must be passed by the present legislature and the session of 1927 and then be referred to the people. This referendum would probably be in 1928.

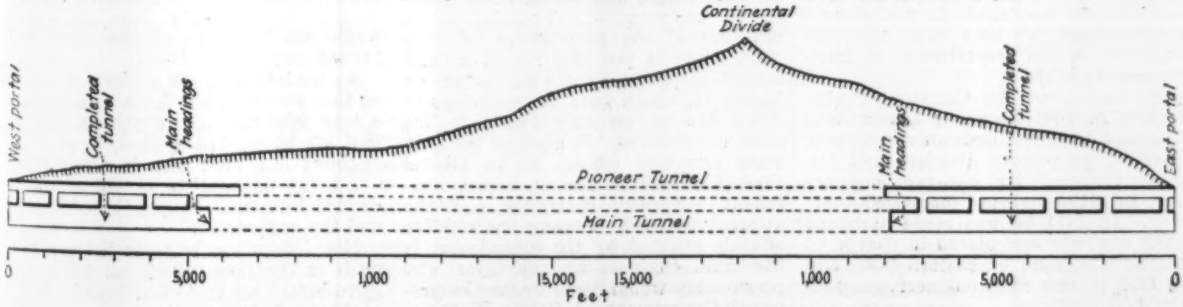
The governor of Pennsylvania has recently signed the enabling act, permitting the sale of the $50,000,000 worth of road bonds approved in November, 1923, by the electors of the state. Passage of this enabling act was necessitated by a decision of the Supreme Court which declared the original enabling act unconstitutional in that it failed to state the purpose for which the bonds were to be issued.

Steel Cables for Long-Span Power Line at Tacoma

In bringing power from the Lake Cushman hydro-electric plant now being built by the city of Tacoma, Wash., it will be necessary to carry the 100,000-volt transmission line across "The Narrows" in the lower end of Puget Sound by a 6,240-ft. span. The idea of using messenger cables on this long span was finally abandoned, and the contract was recently awarded under a plan which calls for the current to be carried by 1¼-in. steel cables.

Two three-phase circuits will be carried across the long span and the design is such that in case one circuit is out of use the other can be made to carry the double load without heating the conductors unduly. In doing double duty in this way a single circuit would be carrying about 600 amperes. Special provision for this high electrical capacity is to be made in the construction of the cables by winding them with an alternate lay.

In other respects the general scheme of the crossing design has not materially changed from that originally contemplated and which was described in *Engineering News-Record*, May 8, 1924. Contract for the steel conductor cables was awarded to John A. Roebling's Sons Co. at a price of $37,612, which covers the construction of six 1¼-in. 35-strand plow steel cables, wound concentrically.



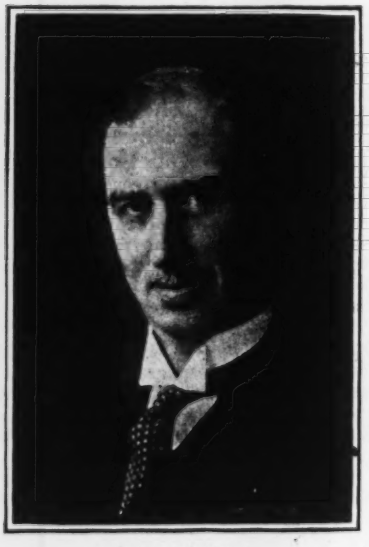
PROGRESS PROFILE OF MOFFAT TUNNEL UNDER THE COLORADO ROCKIES

Canadian Elected to Head Railway Engineers

J. M. R. Fairbairn, Chief Engineer of Canadian Pacific, First to Hold Such Position

J. M. R. Fairbairn, chief engineer of the Canadian Pacific Ry., was elected president of the American Railway Engineering Association at its annual meeting in Chicago March 10-12. He succeeds George J. Ray, chief engineer of the Delaware, Lackawanna & Western. Mr. Fairbairn has the distinction of being the first native-born Canadian engineer to become head of this association. J. G. Sullivan, a former chief engineer of the Canadian Pacific who served as president of the association some years ago, was born and educated in the United States.

NEW PRESIDENT OF AMERICAN RAILWAY ENGINEERS



J. M. R. Fairbairn

Mr. Fairbairn was born in Peterborough, Ont., in June 1873, and was graduated from the University of Toronto in the class of applied science in 1893. Before graduation he spent some of his summer vacations in survey parties of the railroad that he now serves as chief engineer. After graduation he was employed in the government engineering service and in private practice for a few years, returning to the Canadian Pacific as an assistant engineer in the construction department in 1899. For part of the years 1900 and 1901 he was again in the government service, this time as an assistant engineer in the Department of Railways and Canals.

He re-entered the Canadian Pacific service in 1901 becoming successively assistant engineer, division and district engineer on various divisions and districts, then principal assistant engineer and, in 1910, engineer, maintenance-of-way. In 1911 he was made assistant chief engineer and placed in charge of engineering work on eastern lines, and in 1918 became chief engineer, succeeding J. G. Sullivan.

Mr. Fairbairn has been a director of the American Railway Engineering Association since 1920, is a past-president of the Engineering Institute of Canada, a member of the American Society of Civil Engineers since 1913, and of the Institution of Civil Engineers of Great Britain since 1918.

Lakes-to-Gulf Waterway Plans Laid Before Senate Committee

Plans of the Lakes-to-the-Gulf Deep Waterway committee were laid before senators representing lake states at a conference March 13. Further hearings at Chicago, and possibly elsewhere, are planned for this summer, army engineers will be asked to prepare detailed plans for regulatory works on the St. Clair and St. Mary rivers and the committee will try to draft a bill to meet the situation before the next session of Congress, it was announced.

As reconstituted since the death of Senator McCormick, who was chairman, this special committee of the Senate is composed of Senator Reed of Pennsylvanit, chairman; Senators Brookhart, McKinley, Broussard and McKellar, Senator McKinley being the new member.

The conference was harmonious, lake states senators stating they would have no objection to a plan which would not interfere with navigation on the Great Lakes.

Committee members told the conference that investigation thus far had disclosed feasible means of carrying out the purpose. At an estimated cost of $5,000,000 it was said levees could be constructed along the Illinois River, which with a diversion of 10,000 sec.-ft. of water from Lake Michigan, would create a 9-ft. barge channel from Chicago to the Gulf. Regulatory works in the St. Clair and St. Mary rivers would permit this diversion and actually result in raising the level of the lakes more than 2 ft. it was said. The cost of these regulatory works was estimated roughly at $40,000,000.

This plan ties in with plans for continuing diversion of water from Lake Michigan for the Chicago Sanitary District, which recently was given a permit for 8,500 sec.ft. diversion for five years, following the supreme court decision in the diversion case.

Fewer N. Y. State Departments To Be Voted On in Fall

Consolidation into twenty state departments of the much larger number of commissions and bureaus now making up the executive and administrative branches of the government of New York State is provided for in a joint resolution passed by the legislature on March 16, which goes to the voters in November as an amendment to the state constitution. If adopted the only state executive officers to be elected thereafter will be the governor, lieutenant governor, controller and the attorney general. Among the elective officials affected by the amendment is the state engineer and surveyor who presumably would come under the proposed Department of Public Works.

Random Lines

Stealing Our Stuff

We yield space this week to Whiting, the columnist of the Boston *Herald*. Gentlemen—Mr. Whiting:

Have you an engineer in your home? If you have not you are not up to date. Engineers are everywhere and everything. Long gone and forgotten and buried in oblivion are the days when an engineer ran an engine. Now he may be selling insurance or running a social settlement or promoting a stock issue or matching shoe laces.

You, any of you, can have, or be, an engineer. The person who is not, or has not, an engineer today is behind the times. We are in an engineering age.

The dictionary has long admitted a variety of meanings for engineer, but usage is beating the dictionaries. Our favorite Webster says an engineer is "one who designs or constructs, an inventor, also a plotter. One versed in, or who follows as a calling or profession, any branch of engineering. One who manages or runs any stationary or locomotive engine; an engine-driver. One who carries through an enterprise by skillful or artful contrivance, an efficient manager."

It is from the quaint volume of Richardson's dictionary (Bell & Daldy, Fleet St., London, 1867) that we glean the stimulating reminder that "to engine, in Chaucer, is to put upon an engine of torture, and thus to torture, torment." This comes close to the modern usage of "engineer" in the war for efficiency and service. Also from Richardson we capture this quotation from Suckling:

"Proceeded on with no less art,
My tongue was engineer;
I thought to undermine the heart
By whispering in the ear."

We would rather buy grapefruit from a fruit engineer than from a fruit peddler. When we go across the street and upstairs to get our hair cut we want to feel that we are in the hands of a competent cranial and tonsorial engineer.

Any normal man wants to have in his home the security that comes from an experienced dishpan engineer in the kitchen. As matters look now the pay of kitchen engineers is on the upgrade; and we hope they'll have diplomas to prove they are good at engineering.

Maybe if there had been better engineering at the United States Capitol during the last few days the train would not have run off the track and turned over in the ditch.

As we interpret the modern meaning of this excellent word, an engineer is a man who manages anything. From that we go on to the thought that an engineer is a man who does anything.

All the population is going to be divided into two groups, the engineers and the engineered.

Now let's all wake up to the pep and push of the time. Let's all of us resolve before we go to bed tonight to be engineers from now on.

Engineering Societies

Calendar

Annual Meetings

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Louisville, Ky., April 27 to May 2, 1925.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Convention, Chicago, May 12-14, 1925.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Orlando, Fla., June 2-5, 1925.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 22-26, 1925.

The Engineers' Club of Trenton (N. J.) at its regular monthly meeting, March 12, had an address on "Concrete Follies" by R. B. Gage, chemical engineer, head of the state laboratory of New Jersey.

The Louisiana Association of Highway Engineers has been formed with the following officers: W. H. Smith, Jr., Alexandria, president; John F. Irwine, Baton Rouge, vice-president; A. M. Mutersbaugh, Lake Charles, treasurer; Jack Harris, La Place, secretary.

The New Jersey Sewage Works Association will hold its annual meeting at the State House at Trenton, March 27, 1925. The program includes the following papers: "Sludge Drying and Handling," Weston Gavett, New York City; "Workings of the New Jersey Licensing Law for Plant Operators," H. P. Croft, chief engineer, State Board of Health; "Repairing Break in a Deep Tile Sewer Line," Paul Molitor, superintendent, Madison Chatham plant; "The Usefulness of Monthly Reports by Operators," Charles Nichols, Engineer, State Board of Health; and "Progress Report of the Sewage Substation Laboratory," Dr. Rudolfs, chief of the laboratory. Advance information from the committee on forming a national association indicates that the association will retain its present name, but will welcome members without regard to geographical situation.

The Hamilton, Ont., Branch of the Engineering Institute of Canada was recently organized, with the following officers: J. J. Mackay, chairman, and C. H. Marrs, vice-chairman. At the meeting when the society received its charter, speeches were made by O. O. Lefebvre, chief engineer of the Quebec Streams Commission, and J. B. Challies, recently director of water power, Department of the Interior, at Ottawa, the latter speaking on impressions he had gathered at the international power conference which was held in England last summer.

The Illinois, Iowa and Wisconsin Sections of the American Water Works Association met jointly March 17 and 18 at Evanston, Ill., discussed general problems and some local plants of the three states, and inspected the filtration plant at Evanston.

The Brooklyn Engineers' Club at its meeting March 12 had an address on "A New Parking Garage System for Traffic Relief in Congested Districts of Great Cities," by Howard P. Quick, consulting engineer, New York City.

The Detroit Engineering Society at its meeting March 20 will be addressed by Hans Ibsen, bridge engineer, Niagara River Bridge Co., who will tell of the difficulties encountered in the construction of the Michigan Central R.R. bridge at Niagara Falls and will show some slides of the work as it progressed.

The Washington, D. C., Society of Engineers announces, in the first issue of the Washington Engineering Societies Bulletin, meetings of March 18, 19 and 25; the meeting of the 18th included an illustrated talk on "What the Engineer Should Know About Engineering Instruments," by W. H. Kern, of New York City; on the 19th this society was invited to a lecture under the auspices of the Washington Academy of Science, where Dr. Carl Benedicks, director of the Metallurgical Institute of Stockholm, Sweden, spoke on "The Theory of High Speed Steel;" and on the 25th the society will visit the exchange and radio studio of the Chesapeake and Potomac Telephone Co.

Personal Notes

F. B. LYSLE, Philadelphia, Pa., assistant engineer and head of the testing laboratory in the Municipal Bureau of Engineering, has resigned to become associated with the Eastern Clay Products Association.

GEORGE H. SHAW, Philadelphia, Pa., who was chief of the Division of Housing and Sanitation of the city's Department of Health until his recent resignation, is now associated with the Eastern Clay Products Association.

ARTHUR L. MUDGE, lately associated with the engineering firm of Kerry & Chase, Ltd., of Toronto, has been appointed by the Canadian government a member of the staff of the Joint Board of Engineers, Canadian Section, on the St. Lawrence deep waterway project. Mr. Mudge has had a long experience in designing large power plants and his duties will include the preparation of plans for four power developments, which may be embraced in the project.

GORDON ST. GEORGE SPROULE, lecturer in metallurgy at McGill University, Montreal, has been awarded the gold medal presented annually by the Engineering Institute of Canada for the best paper on an engineering or chemical subject. His paper was on "Metals in the Engineering Service."

ARTHUR SURVEYER, of Montreal, president of the Engineering Institute of Canada, was the winner of the first prize of $1,000 in a competition for the best design for a bridge over Montmorency Falls, Que., held by the Public Works Department of Quebec. The second prize of $500 was awarded to Monsarrat and Pratley, consulting engineers, Montreal. Twenty-eight plans were submitted by 21 contestants.

LORENZO C. DILKS, president of Starrett-Dilks Co., Chicago, announces that this company has purchased the interests of Starrett Brothers, Inc., of Illinois, and will operate as general contractors. There are no New York interests in the company.

L. A. GEUPEL, formerly director of the Water and Sewage Department, Indiana State Board of Health, Indianapolis, is now with the Ulen Construction Co., for which company he will design and construct water-works and sewage-treatment plants in Poland.

JAMES L. WARD, president of the J. L. Ward Construction Co., is president, and F. E. WELSH, president of the F. E. Welsh Contracting Co., of Cleveland, Ohio, is secretary and treasurer of the Ward-Welsh Co., Inc., Cleveland, Ohio, a new contracting firm organized to handle special classes of excavation and grading contracts.

J. C. HOLMAN has resigned as vice-president of the A. J. Contracting Co., to become president of the Holman Construction Co., Inc., builders, at 1400 Broadway, New York City.

Obituary

LOUIS RISSE, at one time chief topographical engineer of New York City, who laid out the Grand Concourse in the Bronx, died March 10, at the age of 74 years. Mr. Risse was a native of the province of Lorraine, France, and after graduating as a civil engineer in France came to this country. He spent two years as civil engineer for the New York & Harlem and New York Central railroads, then entered the service of New York City. He was successively engineer of the park department of the Borough of the Bronx, New York City, superintendent of sewers, streets and bridges in two wards of the borough, chief engineer of the borough, and finally chief topographical engineer of Greater New York. His map of the city, made in 1899, exhibited at the Paris Exposition, won a decoration from the French government.

JAMES N. DICK, formerly chief engineer of the Montreal Tramways Co., died at Montreal March 9 after three years' illness, aged 65 years. Mr. Dick had been for twenty-five years in the service of the company and was appointed chief engineer in 1907, holding that position until compelled to retire owing to ill health.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Railway Appliances Shown at Chicago Exhibit

Pneumatic Track Tools—Heavy Motor Cars—Many Crossing Protection Devices Shown

Engineering News-Record Staff Report

LABOR-SAVING devices were even more in evidence at the National Railway Appliances Association exhibit March 9-12 at the Coliseum, Chicago, this year than last. They ranged all the way from track lining devices to heavy motor cars to take the gangs to work and supply them with electric power after they get there.

The exhibit was held, as usual, in conjunction with the annual meeting of the American Railway Engineering Association and the signal section of the American Railway Association. It opened Monday, March 9, a day ahead of the opening of the A.R.E.A. convention, with the idea of giving the members of that association an opportunity to see the exhibits before their meetings began, but as most of the members did not arrive until Tuesday the attendance the first day was small. Many members of both associations feel that the A.R.E.A. might well set aside time for its members to attend the exhibit during its session.

Mechanical Tools

Pneumatic and electrically operated tools for doing almost every kind of track work, except renewing ties, were much in evidence, and the roar of tamping machines always drew a crowd of interested spectators. A new feature in the way of power supply for tamping and other mechanical track tools was a gasoline "Casey Jones" track motor car put out by the Northwestern Motor Co. which has a 7½-kw. electric generator mounted on the body of the car and driven by the Ford engine which propels it. Other cars ranged from such large units as the one above noted to small light ones with special features for one-man operation.

Other types of labor-saving equipment included a number of track lining devices, tie spacer attachments for track jacks, and a motor-operated earth drill for digging post holes, shown by the Buda Co. New cinder and coal handling equipment included a model of an overhead-trolley cinder loading plant by the Blaw-Knox Co., a self-loading bucket by the Howlett Construction Co., and automatic skips by the Roberts & Schaefer Co.

Modifications of the Jordan spreader-ditcher included a pneumatic pin release and raising device for the extension wing, an adjustment which has had to be made by hand heretofore.

Track Fixtures

The display of switch material and other track fixtures was extensive. It included a number of refinements in switch-stands and frogs. The tendency toward the use of one-piece guard rails was demonstrated by new guard rails exhibited by the American Chain Co., the Frog, Switch & Mfg. Co., and the Q. & C. Co.

This year's crop of new rail anchors brought forth one each by the Positive Rail Anchor Co., the Arcco Co. and the P. & M. Co. Something different in the way of crossing paving was shown by the Locomotive Finished Material Co. and the Alan Wood, Iron & Steel Co., a crossing made up of cast iron plates.

Railway Buildings

The T. W. Snow Construction Co. had a model on display of the 50-ton coal chute described in this journal Feb. 5, p. 236. A structure of interest to engineers on roads using oil fuel was a floating roof for large open top oil tanks exhibited in model form by the Chicago Bridge & Iron Works. A skylight specially adapted for railway use was shown by the American 3-Way Luxfer Prism Co.; it has all the exposed metal surfaces adequately protected from attack by gas by a heavy lead coating.

New features in the way of cement and concrete included concrete cribbing for use in restoring embankments, shown by the Massey Concrete Products Co., surfacing and cleaning equipment by the Concrete Surfacing Machinery Co., and the quick-setting Lumnite cement by the At'as Portland Cement Co. Culvert pipe attracted considerable attention through the showing of cast iron spirally corrugated pipe by the American Casting Co. and extra heavy corrugated steel pipe by the Armco Culvert & Flume Mfg. Assn.

Signs and Signals

Color was added to the whole show by the flashing of red and green lights in the numerous switch lamps, semaphores and flashing or wig-wagging crossing signals scattered throughout the three large halls that made up the exhibit. Signal men were busy studying the intricate details of these electrical devices but they were disappointed in having but three out of the many types of train-control devices now under consideration displayed at the show.

New Officers

The new officers of the National Railway Appliance Association, elected at this meeting, are:

J. W. Gillingham, Jr., Hall Switch & Signal Co., president; W. B. Murray, Miller Train Control Corp., vice-president; C. W. Kelly, Kelly-Derby Co., secretary-treasurer; F. M. Hartley, Jr., National Lead Co., and M. C. Beymer, Oxweld Railroad Service Co., directors for three years.

Index Number of Locomotive Crane Sales Discontinued

For a number of months *Engineering News-Record* has been publishing an index number of locomotive crane sales based on information supplied by the Locomotive Crane Manufacturers Association. This service will be discontinued as explained in the following letter:

"Due to the fact that all of the member companies are not now reporting on locomotive crane sales I will be unable to give you this monthly information." (Signed) E. C. Pierce,
Secretary-Treasurer, Locomotive Crane Manufacturers Association,
Cleveland, Ohio.

Statistics Show Status of Manufacturers in U. S.

The Department of Commerce announces that, according to a summarization of the data collected at the biennial census of manufactures, 1923, the value of products (at factory prices) of manufacturing establishments in the United States in that year aggregated $60,481,135,000. This aggregate represents an increase of 38.5 per cent as compared with $43,653,283,000 in 1921, but is 2.5 per cent below the corresponding total for 1919, $62,041,795,000.

Despite the slight decrease in the aggregate value of manufactured products between 1919 and 1923, the actual output of manufacturing industries, measured in quantities, not values, showed a considerable increase, which has been estimated at 19 per cent.

The average number of wage earners employed during 1923, 8,763,233, exceeded by 26.2 per cent the number reported for 1921, 6,946,570, but was 2.6 per cent less than the 1919 total, 9,000,059. The total wage payments in 1923, $10,985,895,000, show increase of 34 per cent as compared with $8,200,324,000 in 1921 and of 5 per cent as against $10,461,787,000 in 1919.

Because of the fact that the products of many manufacturing establishments are used as materials by other establishments, the aggregate value of products as given above is considerably in excess of the total value of finished manufactured products in the form in which they reach the ultimate consumer. A very much better measure of the actual value created by manufacturing processes is the "value added by manufacture," namely, the difference between the cost of materials (including fuel, mill supplies, containers, etc.) and the factory value of the finished products. This aggregated $25,853,151,000 in 1923, an increase of 41.1 per cent as compared with $18,316,666,000 in 1921, and of 4.4 per cent as against $24,753,064,000 in 1919. Thus, despite a slight decrease in aggregate value of products between 1919 and 1923, together with an increase in expenditures for wages, the value added by manufacture increased somewhat, this increase being due to a decline in the cost of materials from $37,288,731,000 in 1919 to $34,627,984,000 in 1923. This latter figure represents a decrease of 7.1 per cent as compared

with 1919, but exceeds by 36.7 per cent the corresponding total for 1921, $25,336,617,000.

The rated horsepower capacity of engines, water wheels, electric motors, etc., used for primary power in manufacturing establishments aggregated 33,749,429 in 1923, an increase of 14.4 per cent as compared with 29,504,792 in 1919. The aggregate coal consumption in 1923 was 241,168,602 tons (of 2,000 lb.), as against 219,518,152 tons in 1919, the rate of increase being 9.9 per cent. (No data as to horsepower and coal consumption were collected at the census for 1921.)

Adopt Specifications for Asphalt Prepared Roofing

Specifications for asphalt prepared roofing, based on the results of investigations conducted by the Bureau of Standards, Department of Commerce, have been adopted by the Federal Specifications Board to serve as U. S. Government Master Specifications for the purchase of this material.

Two weights of this roofing have been covered by the specifications, medium and heavy weight, averaging 45 and 55 lb. respectively per 108 sq.ft. of area. The detailed requirements specified cover appearance, maximum and minimum weight, pliability, and behavior of the roofing on heating. Requirements for the dry felt from which the roofing is to be prepared are also given and correspond to Nos. 48 and 60 respectively for the two weights. Specifications for the nails and lap cement used in applying the roofing are also given, together with methods for its inspection, sampling, and testing.

The investigations on which those specifications are based have been in progress at the Bureau of Standards for four years, and have covered all types of bituminous roofing. They have been made in co-operation with the manufacturers and large consumers of the materials, and with government departments interested in them.

National Campaign for Better Plastering Begun

A nation-wide movement sponsored by the Associated Metal Lath Manufacturers is under way to cause building owners to realize the importance of those parts of a structure which are not seen but which determine the amount of repairing that will be required and the ability of the structure to resist fire. This educational campaign of the National Council for Better Plastering is designed to awaken an appreciation of plastering and to acquaint people with the fact that the plastering base, itself unseen, determines the satisfaction the plastered surfaces will give.

Oscar A. Reum, president of the Contracting Plasterers' International Association, is mailing to plastering contractors a letter urging that they bid on better plastering, even though the original specifications do not call for such bids. Plastering contractors, it is claimed, are ready and willing to do plastering on a steel base so that their work may be permanent and the present annual loss by fire of 7,500 lives and $88,000,000 in property may be reduced. A booklet entitled "Better Plastering" will be sent free on request to the National Council for Better Plastering, 819 Madison Square Building, Chicago.

Business Notes

CHICAGO PNEUMATIC TOOL CO. has appointed the Smith & Woodbury Co., 55 Second St., Portland, Ore., as distributor in Oregon and southwestern Washington.

GIBB INSTRUMENT CO., Bay City, Mich., has appointed F. J. DeLima as sales agent for its electric welding and heating machines in Canada with headquarters in the Keefer Building, Montreal.

N. P. NELSON IRON WORKS, INC., manufacturer of portable truck loaders, has recently moved from Brooklyn, N. Y., to its new and larger plant at Allwood Station, Bloomfield & Erie R.R., Passaic, N. J.

C. L. BEST TRACTOR CO., San Leandro, Calif., in its annual report for the year 1924, announces a substantial gain in the sales of its product which aggregated $5,344,000 during the year. Net profits for the year, before provision for federal taxes, reached the total of $901,830.

ORTON & STEINBRENNER CO., Chicago, Ill., and Huntington, Ind., manufacturer of locomotive cranes, steam and gasoline power shovels and clamshell buckets, announces the appointment of the Wm. M. Bailey Co., Pittsburgh, as its representative for Pittsburgh and the surrounding territory. Mr. Bailey, president of the company, was formerly assistant to the president of the Carnegie Steel Co.

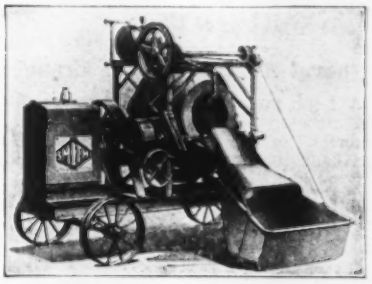
CRESCENT PORTLAND CEMENT CO. is making improvements and enlargements in its present plant at Crescentvale, Pa. Increased production has necessitated additional power facilities to take care of the increased load, and new equipment has been ordered from the Westinghouse Electric & Manufacturing Co. consisting of two 3,000-kw., 2,200-volt, 3-phase, 60-cycle turbine generator units equipped with surface condensers and auxiliaries. In addition, the contract calls for a switchboard substation and six 500 kva. transformers.

JUSTIN GRIESS, vice-president of the McMyler Interstate Co., Cleveland, Ohio, died Feb. 26 at the age of fifty. His death ended a business association with Robert W. Kaltenbach which, beginning shortly after Mr. Griess' graduation from Purdue University in 1896, extended over a period of 28 years. Starting out as Cleveland representatives of several prominent manufacturers, they next established the firm of Griess & Kaltenbach, consulting engineers. A few years later they took over the Interstate Engineering Co., Bedford, Ohio, which was later combined with the McMyler Manufacturing Co. to form the present McMyler-Interstate Co.

Equipment and Materials

Refinements on New 7-S Tilting Concrete Mixer

A tilting mixer in the 7-S size is the latest addition to the T. L. Smith Co. line, thus giving the company a complete line of both tilting and non-tilting types from the 2½-ft. capacity to the world's largest, the 4-yd. mixer, such as was used on the Muscle Shoals dam and the Galveston Causeway. The new

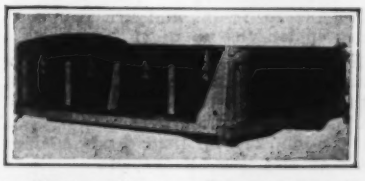


7-S is intended to interest road contractors because of the increasing demand by highway engineers that nothing smaller than a one-bag mixer be used for bridge and culvert work. Its drum is a tilting double-cone. Ease of tilting, through a set of gears with large reduction, adopts the machine either to partial discharge of the batch into wheelbarrows, or complete discharge into a buggy.

Features of the new unit are: Machine-cut engine gears; electric steel drum pinion; chilled iron thrust rollers; dustproof lubrication for boilers; gear-driven drum electrically welded, and tilted by hand from either side; two-cylinder gasoline engine of 6-8 hp., hopper cooled, with magneto, all enclosed in lockable steel, house. All-steel wheels may be had with or without hard rubber tires; the machine is equipped with power loader and automatic measuring water tank.

Steel-Lined, Wooden Truck Body

Constructed especially to resist the shocks of steam shovel loading and used on excavating jobs where rock, stone and broken concrete are hauled, a heavy wooden motor truck body with



steel lining has been announced by the Heil Co., Milwaukee. This demountable body has sides of 1½ in. oak and 2-in. oak floor covered with ¼-in. steel plate in one piece. The side, front and tail-gate are lined with 12-gage steel. The front end, sides, tail gate and tail-gate posts are removable, making it a platform body. The double-acting tail

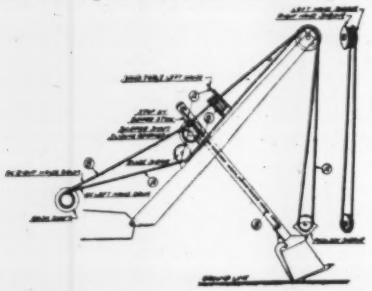
gate with a special platform hinge is of steel-lined oak.

The sides of the body are made with metal stakes and stake pockets. A supporting hinge in the center at the bottom of the tail gate keeps the latter from bulging. The outer edge of the running board is supported by a heavy angle, riveted to the cross members of the sub-frame, which constitutes a bumper or rub rail to keep the body from being damaged when the truck is being driven close to a building, shovel or car.

The body is of the following dimensions: For 3½ to 5-ton trucks: 10 ft., 10 ft. 6 in., and 11 ft. long, 5 ft. 9 in. wide at the front, 6 ft. wide at the rear, with lower sides 18 in. high, and a total height of 24 in.

Shovel Attachment for Crane

A ½-yd. power shovel attachment for the crawler-mounted locomotive crane, described in this journal Feb. 19, p. 337, has been placed on the market by the



Speeder Machinery Corporation, Fairfield, Iowa. It is designed as a light machine for basement excavation and other small jobs. A reversible cable crowd is used. The arrangement of the three main drums and boom hoist drum is such that they may be utilized in employing the machine as a crane, a shovel, or a dragline. For shovel service the boom is 16 ft. long and the dipper stick 12 ft. long.

Publications from the Construction Industry

Building Columns — LALLY COLUMN CO., Chicago, has published a 16-p. illustrated pamphlet describing its patented steel-pipe, concrete-filled columns for building. These units, which are factory built, are used principally in buildings from one to six stories high. In outside diameter the columns range from 12¾ to 3½ in. and are manufactured in lengths up to 21 ft.

Road Forms—LAKEWOOD ENGINEERING CO., Cleveland, Ohio, tells in an 8-p. booklet the success enjoyed by the Carr road forms since they were put on the market in 1923, and outlines their outstanding advantages.

Fire-Safe Buildings—NATIONAL LUMBER MANUFACTURERS ASSOCIATION, Washington, D. C., has issued Vol. V, Chapter 6, of its "Fire Prevention Series." The title is "Fire-Safe Industrial Buildings," and it outlines means of designing and erecting a building for industrial use so that the fire hazard is reduced to a minimum.

Business Side of Construction

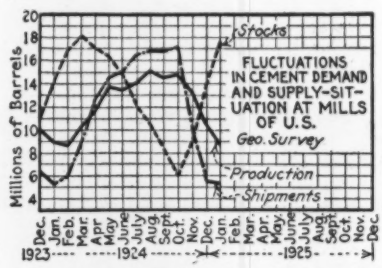
FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Cement and Steel Bar Output Portend Active Concrete Demand

The fact that cement mill reserves for the entire country, Jan. 31, 1925, were far in excess of those usually on hand at this period and also that they were exceeded only by those available at the end of March, 1924, leads to the question as to whether, or not, the cement industry is in greater danger of over-expansion than the other basic materials industries.

At the present rate of accumulation there will be over 21,000,000 bbl. of cement in the nation's reserve stocks by the end of the current month. This would represent an unprecedented quantity and would call for a commensurate demand.

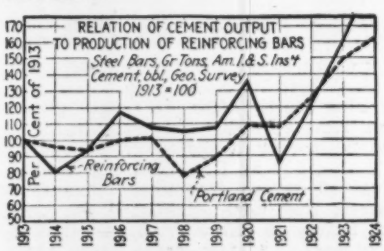
The seasonal fluctuations in supply and demand are shown in the accompanying chart. It will be noted that after March the reserve supply diminishes rapidly as the season advances, until the end of October, after which time the piling up process again sets in.



It is reasonable to suppose that cement manufacturers are not producing more than the construction industry can consume, even during a "boom period." Therefore it is probable that most of this cement will be shipped to jobs or dealers' warehouses between April and October of the current year.

In support of the belief that cement production is not in excess of the potential demand, attention is directed to the accompanying chart showing the relation of cement output to production of steel reinforcing bars.

For the past twelve years, reinforcing bar production has been considerably ahead of cement output, if the relation of each to its 1913 volume is considered.


RELATION OF CEMENT OUTPUT TO PRODUCTION OF REINFORCING BARS
Steel Bars, Gr Tons, Am. I. & S. Ins't
Cement, bbl., Geo. Survey
1913 = 100
Per Cent of 1913
Reinforcing Bars
Portland Cement

The year 1913 is taken in this case as a base, for the reason that it is the nearest year to the 1922-25 construction boom, entirely devoid of wartime inflation.

During two periods only, 1914 and 1921, respectively, did the output of bars drop below that of cement.

The fact that the two materials are equally related to reinforced concrete construction and that the cement is not in excess of the bars, so far as output is concerned, would indicate no imminent over-expansion in the cement industry. It also portends a substantially increasing demand for this type of construction.

The following tabulation shows actual yearly production figures for the two materials. Steel bar output is according to the American Iron and Steel Institute and cement statistics are from the Geological Survey:

	Reinforcing Bars Gross Tons	Portland Cement Bbl.
1913	2,189,000	92,097,000
1914	1,718,000	88,230,000
1915	2,037,000	85,915,000
1916	2,572,000	91,521,000
1917	2,338,000	92,814,000
1918	2,306,000	71,082,000
1919	2,364,000	80,778,000
1920	2,968,000	100,023,000
1921	1,815,000	98,842,000
1922	2,653,000	114,790,000
1923	3,517,000	137,460,000
1924	4,455,000*	148,859,000

* Estimated.

Residential Building Still In the Lead

That the trend in commercial and residential building construction is still strongly upward, while that of industrial building is inclining in the opposite direction, is shown by the accompanying figures.

VALUE OF BUILDING CONTRACTS LET

	1924	1923
Industrial	$204,969,000	$281,611,000
Commercial ...	934,905,000	813,392,000
Total engineering construction	2,002,533,000	1,899,254,000
Residential ...	2,051,643,000	1,735,492,000
Total building construction.	4,481,807,000	3,990,483,000

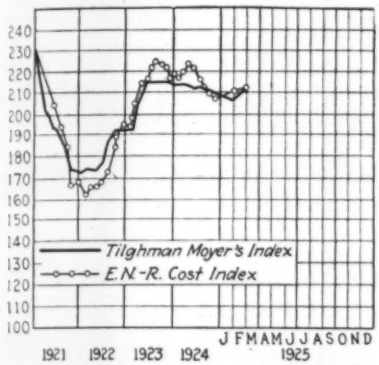
In the above table no industrial awards below $40,000 are included and no commercial buildings under $150,000. The total of engineering construction as published in the Construction News Section of *Engineering News-Record*, contains no lettings under $15,000 for waterworks and excavations; nothing under $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings. Residential and total buildings are according to F. W. Dodge Corporation's statistics covering seven-eights of the building activities of the United States.

All engineering construction gained 5 per cent during 1924 over the year preceding. Buildings alone gained 12 per cent. Of the separate classifications, commercial buildings increased 15 per cent and residential, 18 per cent over 1923. Industrial construction dropped over 27 per cent during the year.

From present indications, residential construction is still in the lead, despite the urgent demand for more office buildings and other forms of commercial floor space, evident since the heavy production period of 1923.

"E.N.-R." Cost Index and the Cost of Banks

The curves are Tilghman Moyer's index of the cost of building banks and the *Engineering News-Record* Cost Index of general construction from January, 1921, to February, 1925. Considering the wide variation in the method of computing these two numbers the similarity of trend is striking.



BANKS AND GENERAL BUILDING COST

The bank index is calculated from current bills and estimates for the kind of labor and materials used in bank construction. As the Tilghman Moyer Co. of Allentown, Pa., states: "For other types of buildings these figures are not strictly accurate, but may be used to indicate the general trend of costs."

The *E. N.-R.* Cost Index is not intended to apply to any one class of construction (let alone to a particular type of building) or to any one section of the country.

It is of value to construction men to know the various sound applications of the *E. N.-R.* Cost Index Number. Won't you tell the editor in what way you are using it?

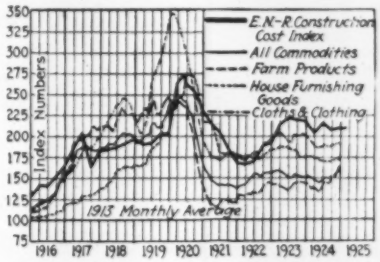
Decrease In Volume Of Wholesale Trade

A comparison of *Engineering News-Record's* Construction Cost Index Number with index numbers of wholesale prices compiled by the Bureau of Labor Statistics, shows conformity during the past nine years, with one exception, that of cloths and clothing during the 1919-20 inflationary period.

The year 1925 started off with these indices all pointing upward, except that of cloths and clothing. The construction cost curve does not promise to recede. A recently decreased volume of wholesale trade may bring down some of the others, when returns for February and March are in.

Other depressing influences are, declines in sales of groceries and shoes and lower prices of hides.

On the other hand there are several factors that may tend to buoy the all commodities index at the January level. They are: heavier volume of drug and dry goods sales; advanced cotton textile prices; increased textile output.



DEPT. OF LABOR AND E. N.-R. COST INDICES COMPARED

Public Bond Sales in February

There were few bonds of exceptional size in the February offerings. The total for the month is $73,299,708 as compared with $127,410,663 for January and $94,713,665 in February a year ago, according to *The Commercial and Financial Chronicle.*

Some of the larger issues were: $7,000,000 4 per cent bonds, Philadelphia; $5,000,000 4-4½ per cent bonds, State of West Virginia; $3,800,000 3½-4 per cent, Jersey City, N. J.; $3,500,000 4½ per cent, Los Angeles, Calif.; $3,000,000 4 per cent, Chicago Sanitary District, Ill. The rates ranged from 3½ to 6 per cent.

REPRESENTATIVE PUBLIC BOND SALES, FEBRUARY, 1925

State	Purpose	Amount	Rate per Cent	Sold For	Basis	Dated	Maturity	Purchased By
Massachusetts	Parks	$1,000,000	4	102.3391	3.78	Jan.	1926—63	Kiddes, Peabody & Co. and National City Co.
	Parks	135,000						
	Sewers	650,000						
	Water	1,138,000						
West Virginia	Roads	1,900,000	4½	100.004	4.13	Jan. 1	1931—50	W. A. Harriman & Co. and others
	Roads	3,100,000	4					
County								
Alleghany, Md.	School	500,000	4¼	101.26	4.16	July 1	1940—55	Nelson, Cook & Co. and others
Bryan, Okla.	Road	50,000	5	.....	.....	July 1	1941—42	Wm. Breg & Co.
Brown, Minn.	Road	250,000	4½	100.89	4.17	Mar. 1	1935—44	Minneapolis Trust Co.
	Drainage	18,000	4½	100.50	4.19	Mar. 1	1930—44	Wells-Dickey Co.
Cass, Ind.	Roads	19,000	5	104.68	4	Feb. 15	1926—35	The City Securities Co.
Cuyahoga, O.	Sewers	332,000	5	104.06	4.40	Mar. 1	1926—40	Otis & Co.
	Water	123,000						
De Kalb, Ind.	Road	17,000	4½	102.10	4.07	Mar. 1	1926—35	The Merchants' Nat. Bank
Franklin, Ind.	Bridge	75,000	4½	104.025	.....	.....	.....	Breed, Elliott & Harrison
Grady, Okla.	Road	200,000	4½	101.31	.....	.....	25 yrs.	Prescott, Wright & Snider Co.
Green Lake, Wis.	Highway	150,000	5	106.61	4.23	Oct. 1	1934—37	Markesan State Bank
Hamilton, N. Y.	Highway	100,000	5	110.47	4.18	Jan. 1	1926—45	Geo. B. Gibbons & Co. Inc.
Jackson, Ind.	.....	4,500	5	104.28	4.18	Feb. 15	1926—35	Fletcher-American Co.
Jefferson, O.	Improvement	176,310	5	102.58	4.46	Feb. 1	1927—34	Detroit Trust Co.
Koochiching, Minn.	Ditch	40,000	6	100.91	5.90	Jan. 1	1925—45	Freeman, Smith & Camp Co.
La Porte, Ind.	Highway	106,600	5	104.61	4.06	Feb. 16	1926—35	City Securities Corp.
Lake, Tenn.	School	25,000	5	130.86	4.73	Jan. 1	1945—50	Caldwell & Co.
Lake, Ind.	Highway	462,000	5	102.61	.....	Aug. 15	1925—34	The Meyer-Kiser Bank and others
Marion, Ind.	Road	196,000	4½	102.06	4.11	Jan. 1	1926—35	Fletcher Savings & Trust Co.
	Flood Prevention	600,000	4½	101.7224	4.04	Jan. 1	1927—45	Fletcher Savings & Trust Co.
Maury, Tenn.	Highway	55,000	4½	104.91	4.60	Dec. 1	1940—43	Joe. B. Palmer & Co.
Marion, Mo.	Light and Water	15,000	5½	100	.....	Dec. 15	20 yrs.	Mercantile Trust Co.
	Light and Water	10,000						
	Sewer	10,000						
Township								
Daugherty, Pa.	Road	30,000	4½	.....	.....	Sept. 1	1929—43	A. B. Leach & Co.
Hanover, Pa.	Road	28,000	5	107.94	4.34	Mar. 1	1930—50	E. H. Rollins & Sons
Municipal								
Atlanta, Ga.	Street Impv't.	122,000	4½	101.20	.....	Feb. 1	1927—34	Harris, Forbes & Co.
Athens, Ga.	Water Works	58,000	4½	104.02	4.27	Jan. 1	1954	National City Co.
Beaufort, N. C.	Street Impvt.	75,000	6	102.70	5.68	Jan. 1	1926—35	C. W. McNear & Co.
Brattleboro, Vt.	Water	550,000	4	98.33	4.18	Mar. 1	1926—55	E. H. Rollins & Sons
Beverly, Mass.	High School	200,000	4	101.469	.....	Feb. 1	1926—45	Eatabrook & Co.
Burlington, Wis.	City Hall	30,000	5	102.65	.....	Feb. 1	1926—35	First Wisconsin Trust Co.
Birmingham, Ala.	Pub. Impvt.	240,000	5½	104.63	4.55	Mar. 2	1926—35	First National Bank
Canton, O.	Street Impvt.	11,247	5	101.56	.....	Sept. 1	1926—34	W. L. Slayton & Co.
	Storm Sewer	23,951						
Dayton, O.	Bridge Impvt.	100,000	4½	102.462	4.255	Feb. 1	1926—50	Eldredge & Co.
	Storm Sewer	100,000						
	Sewage Disposal	300,000						
Eustis, Fla.	Street Impvt.	76,000	5½	101.25	.....	Jan. 1	10 yrs.	First State Bank
Ellsworth, Kan.	Water Works	23,500	4½	100.70	4.38	Jan. 1	1927—37	Citizens State Bank
Gadsden, Ala.	Bridge	25,000	6	106.40	5.47	April 1	1945	Steiner Bros.
Lima, O.	Sewer	704,015	5	101	4.89	Feb. 15	1927—51	R. M. Grant & Co. and others
Los Angeles, Calif.	Improvement	1,300,000	5½	100.01	5.165	Feb. 1	1926—64	Anglo-London Paris Co.
Long Beach, Calif.	Harbor Impvt.	500,000	4½	100.029	4.24	Aug. 1	1961—64	Eldredge & Co. and others
Scarsdale, N. Y.	Paving	24,444	4½	101.03	4.29	Feb. 1	1927—40	Scarsdale Nat. Bank
	Paving	22,083	4½	100.72	4.21			
	Sewer	15,000	4½	101.67	4.24			

Weekly Construction Market

A DECLINE in cost of construction can hardly be expected at this particular season of the year. Since 1915, the month of March has witnessed price advances in six out of ten instances.

While there has been considerable resistance to further increases in general costs, evident since the first of the year, a steady gain in contract letting since the week of Feb. 26, does not portend any recession from the present construction cost level.

Contract letting has shown gains during the period just mentioned in both private and public work, and particularly in number and value of large commercial building construction at a minimum value of $150,000.

The same can not be claimed for contracts covering industrial construction; this is probably due to the present restraint of all tendencies toward over-expansion.

Part of current buying is for replenisment or reserve stocks. During the past two years there has been little purchasing on this basis. There is no present danger of a piling up of undesirable inventories, since no market promises any abrupt advance in prices.

In the avenues of trade not specially related to construction, we find evidence of improvement in increased corporate earnings, and output of iron and textiles.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.90	$4.15	$3.10	$3.35	$3.07½	$3.15	$3.35	$4.25
Structural rivets, 100 lb.	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.80	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.40	3.38	3.00	3.25	3.87½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	53.2%	43%	56½%	54.25%	36%	44.7@55.5%	45%	59.49
Cast-iron pipe. 6 in. and over, ton	54.60@55.60	56.00	56.00	49.20@50.20	55.50	62.00	53.00	55.00	60.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.30	2.05	2.20	2.42	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	3.00	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.25	1.40	2.00	3.00	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	3.00	1.75	2.50	2.15	3.00	2.25
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	60.00	34.00	56.00	55.00	39.75	35.75	30.00	23.50	60.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	23.00	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.50@2.75	1.45	1.85	1.26	1.35	2.70	1.60	2.80	10.50
Common brick, delivered, 1,000	18.00	10.50	12.10	12.00	—12.50	12.00	15.50	14.50	17.50
Hollow building tile, 4x12x12, per block	Not used	.0808	.0941	.06	.07	.085	.....	.11	.12
Hollow partition tile 4x12x12, per block	.1162	.0808	.0941	.06	.....	.085	.108	.11	.10
Linseed oil, raw, 5 bbl. lots, gal.	—1.19	1.25	1.30	1.25	—1.21	—1.33	1.34	1.12	1.11
Common Labor									
Common labor, union, hour	.75	.30		82½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.75	.50@.55	.35@.50	.50	.50	.20@.25

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 62½c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; lump finishing lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.60 for Kelly Island and Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of March 5, the next on April 2.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand stone, gravel and lump lime per ton. Stone, lime and tile are delivered; sand, gravel and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.90). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

February Business Failures Heavier Than in 1924

That the number of commercial failures in the United States during last month, was greater than for any February since 1922, is shown by the accompanying figures prepared by the R. G. Dun Co.

The money value of liabilities involved was heavier than a year ago but considerably under January, 1925.

NUMBER OF COMMERCIAL FAILURES

	1925	1924	1923	1922
January	2,317	2,108	2,125	2,723
February	1,793	1,730	1,508	2,331
March	....	1,817	1,682	2,463

LIABILITIES

	1925	1924
January	$51,272,508	$51,272,508
February	40,123,017	35,942,037
March	.....	97,651,026

Since the number and value of March defaults are normally above those of the preceding month, an increased number of business mortalities is expected to show up in the March, 1925 report.

Call money quoted at 4 per cent, March 16; year ago, 3½ per cent.

Time loans: short terms, 4@4½ per cent; longer periods, 4½@4¾ per cent.